Charles University in Prague

Faculty of Social Sciences
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MASTER THESIS

Central Bank Interventions and Their Influences on Exchange rates: The Case of Turkey

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Prague, January 6, 2014

Signature

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Abstract

This study attempts to analyze the efficiency of intervention policy in Turkey during the period between 4.1.2005 and 31.12.2012 with a sub period which is between 4.1.2007 and 31.12.2010. For our study purpose, therefore we investigated how interventions with pre-announced auctions as a whole influence the exchange rates. Further, we analyze whether there is an asymmetric effect among the buying and selling transactions with respect to their impact on the exchange rates. In the study, the E-GARCH model is employed to find the asymmetric effect. The final object of this study is whether buying auctions which are conducted to serve for only purpose of increasing international reserves influence the exchange rates. We evaluate the efficiency of transactions in the same direction of central bank statements. In conclusion, the findings did not amount to any significant impact of total transaction on exchange rates. The study findings also suggest that there is asymmetric effect among the selling and buying transactions. The amounts of selling transaction have a negative impact on both level and volatility while buying auctions did not have any significant effect on them. As a new research result, we found that buying auctions served well with respect to their contributions to reserves while they do not influence the exchange rates.

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Acronyms

FX Foreign Exchange

CBRT Central Bank of the Republic of Turkey

FED Federal Reserve System

BoJ Bank of Japan

ECB European Central Bank

G5 France, Germany, Japan, the United Kingdom, United States

G7 France, Germany, Japan, the United Kingdom, United States, Canada, Italy

TRY Turkey Lira

USD US Dollar

EUR Euro

JPY Japan Yen

D-MARK Deutsche Mark

CZK Czech Koruna

INR Indian Rupee

Master Thesis Proposal

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Notes: The proposal should be 2-3 pages long. Save it as "yoursurname_proposal.doc" and send it to mejstrik@fsv.cuni.cz, tomas.havranek@ies-prague.org, and zuzana.irsova@ies-prague.org. Subject of the e-mail must be: "JEM001 Proposal (Yoursurname)".

Proposed Topic:

Central Bank Interventions and Their Influences on Exchange rates: The Case of Turkey

Topic Characteristics:

The foreign exchange market intervention is defined as sale or purchase of foreign assets against the domestic ones by Central banks. In other words, any action taken by an agent of the governments usually thorugh central banks is aimed to influence exchange rates. Central banks intervene foreign exchange markets by sterilize and unsterilize interventions but also interventions can be classified as secret and reported interventions. They try to affect exchange rates through three channels;Portfolio, signaling and noise trading channel. Before Bretton Woods exchange system was abandoned , countries used whenever they felt that they needed to make interventions in order to keep exchange rates under certain predetermined exchange rate band . However, since the breakdown the Bretton Woods, foreign exchange market interventions have become discretionary policy instruments. Even though, many studies have been made on effect and efficiency of foreign market operations, findings from the them are in conflict. Some argue that interventions in foreign market does not have effect on level but increases volatility in exchange rates while others supports interventions since they believe interventions influence level of exchange rates and decrease volatility as IMF Executive Board suggested its member countries that they should intervene to counter disorderly market conditions. The controversial issue regarding the efficiency and effects of central banks's intervention policies is one of the reason why I want to study on efficiency of intervention. Another reason is that although many research have been made and findings have been presented, there is relatively small amount of research and study on effects of exchange rate interventions in emerging countries. Apart from this,in Turkey there is reserve accumulution policy launched by the begining of 2002. For this purposes, central bank started to conduct buyin auctions. Since central bank states that buying auction are conducted for only purposes of increasing internation reserves without resulting in any changes in volatility or level of exchange rates . In this respect, we investigate also influences of buyin auction on exchange rates.

Hypotheses:

1. Hypothesis #1: Total Net Amount of the Intervention Operations by Central Bank of Turkey Republic did not affect on level of exchange rates but decreased volatility of exchange rates in a period between 4.1.2005 and 31.12.2012
2. Hypothesis #2: There is no difference between purchase and sales transactions with respect to their impact on level and volatility of exchange rate
3. Hypothesis #3: buying auction did affect neither on level nor volatility of Exchange rates in a sub period of between 4.1.2007 and 31.12.2010

Methodology:

Regarding the econometric model, I am going to use E-GARCH model in order to observe both total impact of interventions and analyze whether there is a difference in with respect to impact of sales and purchases transactions on exchange rate's level and volatility. In the study, daily indicative selling exchange rates of USD/TRY parity are employed for the exchange rate data. Also we take into account that all direct interventions and pre-announced auctions through sales or purchasing of USD dollars were conducted in USD during the period between 4.1.2005 and 31.12.2012. Main data source for our study is the database of Central Bank of Turkey Republic.

Outline:

- Introduction
- Literature review
- Data & methodology
- Results
- Discussion
- Conclusion
- References

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Chapter 1

Introduction

Since the mid-1970s, after the abandonment in 1973 of the Bretton Woods System, which required countries to peg their exchange rates, most developed countries have shifted their exchange rate regime from an *adjustable* peg exchange one to a pure *floating* regime in which exchange rates are determined by supply and demand in the international exchange rate market. During the period of Bretton Woods, policymakers used the intervention option solely for maintaining rates in a predetermined parity whilst, during the breakdown of Bretton Woods, a discretionary policy with regard to foreign exchange interventions was employed, i.e., one was performed whenever a country's policymaker felt it should be done. In fact, because the protection of Bretton Woods against short-term capital movements was removed, policymakers had to protect their own country's currency values against rapid and sudden capital changes through interventions on the foreign market exchange. Because of the increase in capital movements and the increase in volume and importance of the foreign exchange rates, this led to increased uncertainty, resulting in high volatility of exchange rates. Therefore, policymakers have become more cautious regarding possible negative effects of rapid changes in capital movements. The increasing importance and common usage of official interventions since the 1970s have made it one of the most addressed topics in the fields of economics and finance. Even though policymakers view interventions in foreign exchange markets as useful policy, not only for influencing levels of exchange rates but also for reducing volatility of rates, the literature demonstrates no consensus regarding the efficiency of official interventions,, and foreign exchange intervention is considered a highly controversial policy. Some view intervention as not only ineffective policy for affecting foreign exchange rate level but also as actually increasing volatility in rates. Others, however, argue that intervention policy does impact level and does reduce volatility of exchange rates. Nevertheless, some researchers feel that intervention policies are a waste of time since they affect neither level nor volatility of foreign exchange rates (Dominguez, 1993).

The main objective of this thesis is to study the efficiency of official interventions implemented by the Central Bank of the Republic of Turkey (henceforth, CBRT) and to apply a fresh perspective to the literature regarding the efficiency and effects of such interventions in the context of an emerging country like Turkey. Although much research and

many studies have already been performed in the context of developed economies, small attention has been given to their efficacy in emerging countries. Therefore, we intend to contribute to the existing literature a study related to an emerging country and, at the same time, provide policymakers of such countries with useful information regarding the efficiency and effects of foreign exchange interventions on exchange rates as a viable policy. This study will then explore the impact of official interventions as a whole (i.e., including direct interventions and auctions) with respect to the USD/TRY rate level and will analyze in detail whether interventions reduce volatility of USD/TRY. Besides the impact of the total number and kind of interventions on exchange rates and volatility, we will also try to determine whether a significant difference exists between foreign exchange buying and selling transactions with respect to their impacts on exchange rate level. Lastly, as a new contribution, our study will investigate the efficiency of foreign exchange buying auctions under a moderate reserve policy in Turkey. For these purposes, our study will employ the E-GARCH model.

The thesis is structured as follows. Chapter two presents a literature review. In addition to sub-sections on findings and results from previous studies regarding foreign exchange intervention policy, the historical background of interventions from the 1970s through today and the reasons for them will be included. We will discuss some types of interventions and the general theories of intervention channels that the central bank has used to affect exchange rates. Lastly, we will review previous studies in advanced economies and in emerging countries. Then, we will provide the existing literature on the foreign exchange history in Turkey. The subsequent section is called Data and Methodology. In it we state data and the model that we will use in our empirical research for our hypotheses mentioned previously. Next we will present results and discuss them. Lastly, we will conclude our findings in the conclusion chapter.

Chapter 2

Central Bank Interventions

2.1 Foreign Exchange Interventions

The literature contains some similar definitions of official foreign exchange market intervention, which is broadly defined as any transaction or announcement by an official agent of a government that is intended to influence the value of an exchange rate (Dominguez, 1993). Another definition includes such actions as buying or selling foreign exchange by monetary authorities against their own currency for the purpose of affecting the exchange rate (Sarno & Taylor, 2011). Although intervention decisions are often made by authorities in the ministry of finance or the treasury department, resultant actions are taken by central banks (Dominguez, 1998). Intervention operations usually occur in the dealer markets even though each central bank has its own specific methods of intervention. Some central banks directly contact the foreign exchange desks of commercial banks to achieve maximum visibility while others prefer to intervene secretly so that market participants receive no information.

The exchange rate in a floating rate system is expected to be determined by market supply and demand. But, Meese & Rogoff (1983) found that any structural exchange models are not superior to a random walk in explaining movements of exchange rates. Out of many other relevant studies, only a few were able to find any evidence showing the relation between economic fundamentals and exchange rates even in the long term. Mark (1995) showed that primary economic fundamentals have a positive impact on exchange rates only over long time periods. In short time periods, exchange rates deviate from the values which reflect the changes in economic fundamentals (Sarno & Taylor, 2001). Therefore, policymakers in monetary authorities are forced to intervene in foreign exchange markets to remedy the instability in exchange rates.

The main motivations for central banks to intervene in foreign exchange markets are the following:

- To affect level of the foreign exchange rates: If policymakers think that the exchange rate is significantly different from what it should be, central banks can intervene to affect its value. Because large deviations from required exchange rate values can negatively impact foreign trade or can have inflationist impacts on price levels.

- To reduce excessive volatility of foreign exchange rates: Since high volatility in foreign exchange rates can result in higher costs related to foreign trade, central banks intervene to reduce high variances in exchange rates and calm disorderly market conditions so that the size of their countries' foreign trade is reduced. Countries where inflation targeting drives monetary policy and a high level of pass-through from exchange rates to domestic prices are more sensitive to changes in nominal exchange rates.
- To provide foreign currency liquidity: Disorderly market conditions can result in lack of foreign currency liquidity, causing many financial institutions to suffer from lack of liquidity. Therefore, central banks intervene to increase liquidity for banks and other financial institutions so that they can meet their liabilities and obligations.
- To increase foreign currency reserves: Central banks want to have a strong foreign currency reserve position in order to gain credibility and increase the ability to redeem debt in foreign currency or clear a debt. Having strong currency reserves is more important in emerging countries where external or internal shocks are frequently seen.
- To participate in coordinated and multinational interventions: Central banks can intervene collectively to support a particular currency.
- To signal future monetary policy: Central banks sometimes prefer to use interventions as a signal for changes in the future monetary policy.

2.2 Classification of Foreign Exchange Interventions

In this section, we will present types of interventions employing various perspectives used by Agcaer (2003). Interventions are sorted according to sterilized-vs.-nonsterilized and secret-vs.-reported interventions. In addition, interventions can be classified as unilateral or coordinated and as in the same direction as movement of exchange rates or in the opposite direction as movements of exchange rates.

2.2.1 Sterilized-vs.-Nonsterilized Interventions

When a central bank decides to reduce the value of its own domestic currency, it buys a foreign currency and sells its own, leading to an increase in the domestic money supply. On the other hand, to increase the value of the domestic currency, the reverse transaction is performed, leading to a decrease in domestic money supply. A sterilized intervention occurs when a central bank acts simultaneously or with a very short lag time to offset the effects of changes in foreign

assets on the domestic monetary base (Sarno & Taylor, 2001). A nonsterilized intervention occurs when a central bank buys or sells foreign assets against domestic ones without any offsetting actions. Basically, nonsterilized interventions change the stock of base money, thereby changing the money supply and interest rates (Aguilar & Nydahl, 2000). As can be clearly seen, nonsterilized interventions are like any other open market operation with the exception that foreign assets are bought and sold rather than domestic ones (Dominguez, 1998).

On the other hand, sterilized, official interventions include an offsetting domestic asset transaction so as to leave the monetary base unchanged. Transactions for sterilization can be made through buying and selling of domestic government securities or through repo transactions. As an example, when a monetary authority decides to intervene by selling foreign currency to the market, it will buy domestic currency from the market. The transaction is sterilized through an open market purchase of domestic government securities in order to leave the monetary base unchanged. Therefore, a sterilized intervention changes only the currency composition of domestic and foreign assets of private sector portfolio investments with a constant money supply (Aguilar & Nydahl, 2000). The difference between sterilized and nonsterilized interventions can be best explained with a central bank's balance sheet, like the one of a central bank shown in Figure 2.1[1]:

Figure 2.1: Balance Sheet of a Central Bank

ASSETS	LIABILITIES
-Net Foreign Assets	-Monetary Base
Gold	Currency in circulation
Foreign	Deposits held by commercial banks
-Net Domestic Assets	-Net Worth
Government Securities	
Loans to commercial banks	

[1] This figure is courtesy Sarno & Taylor (2001).

To begin, the central bank's balance sheet is as shown in Figure 2.1. On the asset side, foreign assets consist of gold and foreign currency bonds while domestic assets are domestic government bonds and loans to commercial banks. On the liability side, the monetary base consists of total currency and deposits held by commercial banks.[2] Since both sides of the balance sheet are equal, we can formulate the equation as follows:

$$\text{Monetary Base (M)} = \text{Net Foreign Assets (NFA)} + \text{Net Domestic Assets (NDA)} \quad (2.1)$$

When the central bank performs a foreign exchange market intervention, both sides of this balance sheet will change. For example, if the central bank decides to sell (buy) foreign assets, since net foreign assets decrease (increase), M will also decrease (increase) by the same amount so as to balance the sides of the balance sheet. Equation (2.2) shows how a sale of the foreign asset affects the elements on both sides of the balance sheet:

$$\downarrow \text{M} = \downarrow \text{NFA} + \text{NDA} \quad (2.2)$$

As mentioned earlier, this kind of intervention, which is nonsterilized, is very similar to open market operations with regard to their impacts on monetary base.

On the other hand, when the intervention is sterilized, an offsetting transaction takes place. As an example of a selling intervention, the central bank can sterilize the intervention by buying domestic government bonds or domestic bills. Equations (2.3) and (2.4) describe how this type of sterilization works:

$$-\Delta\text{NFA} = \Delta\text{NDA} \quad (2.3)$$

$$\leftrightarrow \text{M} = \downarrow \text{NFA} + \uparrow \text{NDA} \quad (2.4)$$

Sterilized interventions are usually preferred, especially in developed countries, because neutralizing the money-market effect of interventions prevents exchange rate policy from interfering with domestic monetary policy (Aguilar & Nydahl, 2000). There is a consensus that nonsterilized interventions affect exchange rates analogous to monetary policy, by modifying the monetary base through changes in monetary aggregates, interest rates, real demand for goods and assets, and expectations, all of which ultimately influence exchange rates. The impact of sterilized interventions on exchange rates is not clear and certain. In theory, sterilization affects them by changing the relative supply of domestic and foreign bonds or, if it cannot affect them through monetary channels because the monetary base is kept constant (Edison 1993), by

[2]For simplicity, we assume that net worth equals zero.

changing expectations instead. Since its impact on exchange rates is controversial, most of the studies made on efficiency of interventions have been devoted to analyzing the effects of sterilized interventions.

2.2.2 Secret / Reported Interventions

Nowadays, central banks, especially those located in developed countries, usually inform the public regarding foreign exchange interventions whereas until the beginning of the 1990s, they typically used secret interventions, i.e., those that the central bank does not make public (Dominguez, 1998). Dominguez & Frankel (1993b) present some motivations behind secret foreign interventions.

- In case of interventions made by any authority other than the central bank, it can be aimed at restricting the effects of interventions
- When exchange rate policy interferes with long-term monetary policies to protect credibility of central banks
- A central bank of a certain country can be obliged to join interventions performed by other countries' central banks because of political reasons
- When exchange rates move strongly in one direction and the central bank intends to increase volatility of rates in order to show that the current tendency in exchange rates is actually weak
- When volatility of exchange rates is high and credibility of the central bank is low, policymakers prefer intervention without notification of the public
- Central banks can use secret interventions when they decide to change the level of international reserves

By the beginning of the 1990s, central banks had begun to inform the public regarding the size and price of interventions. Therefore, data and information about interventions can now be found in the financial press, newspapers, and so on besides of official notifications made by central banks.

2.2.3 Unilateral/Coordinated Interventions

A central bank can intervene on its own to impact an exchange rate, or central banks sometimes prefer to intervene jointly, in other words, several national banks coordinate foreign exchange market interventions. Changing a particular exchange rate not only affects the exchange market of the country in which interventions are implemented but also other countries' exchange markets. Therefore, central banks of some countries, especially those of developed countries,

will sometimes take coordinated actions to affect a particular exchange rate such as occurred with the Plaza Agreement of September 22, 1985, and the Louvre Accord of February 21 and 22, 1987. Table 2.1 shows examples of coordinated interventions performed in the past.

2.2.4 Leaning with the Wind and Leaning against the Wind

Interventions which aim to support the direction of exchange rates are described as *leaning with the wind*. On the other hand, interventions to change the direction of exchange rates are termed *leaning against the wind*. However, determining the directions of exchange rate movement, especially when changes in exchange rates are particularly volatile, is sometimes difficult.

Central banks usually apply interventions in opposite directions to stabilize exchange rates which are volatile. Also, central banks use this kind of intervention when they aim to signal future monetary policies.

Table 2.1: Coordinated Interventions

Date	Central Banks	The Purpose of Intervention	Type of the Intervention
October 1974-March 1975	FED, Bundesbank, Swiss National Bank	To slow depreciation of the dollar To offset volatility in the dollar-Mark and dollar-Swiss franc rates	Purchase of the USD
1978-1979	FED, Bundesbank, Swiss National Bank,BoJ	To support dollar	Purchase of the USD
September 1985-Plaza Accord	G5 countries	To weaken strong dollar	Sales of USD against currencies of the rest of G5 countries
February1987	G7 countries	To foster stability of FX rate	Purchases of USD

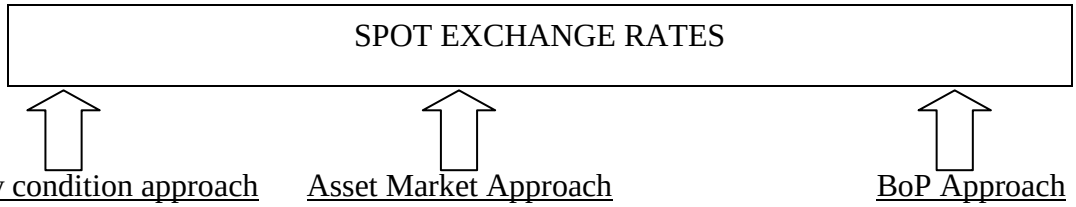
Date	Central Banks	The Purpose of Intervention	Type of the Intervention
1988-1990	G7 countries	To foster stability of ERs	Purchases and sales of USD
1991-1992	FED, European Central Banks	To foster stability of ERs around current levels to support dollar	Purchases and Sales of D-Mark and JPY
April 1994-August 1995	FED, BoJ, Bundesbank and other individual European Central Banks	To support dollar	Sales of D-Mark and JPY
June 1998	FED, BoJ	To support yen	Purchase of JPY
September 2000	FED, BoJ, ECB and other central banks in Europe	To support Euro	Purchase of EUR
November 2000	ECB and other euro zone central banks	To support Euro	Purchase of EUR
September 2001	BoJ, ECB and other euro zone central banks	To weaken yen	Sales of JPY for USD and EUR
March 2011	G7 countries	To control yen	Sales of JPY

Source: Reuters

2.3 Determinants of Exchange Rates

Because determining exchange rates is not simple, there are many theories that try to explain these determinants. Basically, there are three main approaches—the parity condition approach (purchasing power parity), the asset market approach, and the balance of payment approach, and these can be viewed as complementary. Figure 2.2 shows exchange rate determinants with respect to these approaches.

Figure 2.2: Determinants of Exchange Rates



Parity condition approach	Asset Market Approach	BoP Approach
-Relative inflation rates	- Relative interest rates	-Current account balances
-Relative interest rates	-Prospects for economic growth	- Portfolio investment
-Forward exchange rates	- Supply and demand for assets	- Foreign direct investment
-Interest rate parity	- Outlook for political stability	- Exchange rate regimes
	- Speculation and liquidity	- Official monetary reserves
	- Political risk and controls	

Before presenting the channels through which interventions affect exchange rates, we will discuss the theories that explain in detail exchange rate determinants. Below we also discuss the monetary approach in addition to those presented above.

2.3.1 The Purchasing Power Parity Approach (Parity Condition Approach)

The purchasing power parity (PPP) approach is the oldest and the most widely accepted approach among the other exchange rate determination approaches. Basically, this approach assumes that long-term exchange rates are determined by relative prices of foreign and domestic goods. In other words, changes in long-term exchange rates tend to reflect changes in relative prices of domestic and foreign goods. The theory assumes the "law of one price," meaning that differences in prices of a certain good in different countries are eliminated by market agents. Otherwise, arbitrage will exist. Equation (2.5) helps us understand the PPP approach.

$$P^D = \text{ER} \times P^F \qquad (2.5)$$

In equation (2.5), P^D is defined as a price of a good in terms of domestic currency, P^F is the price of the good in terms of a foreign currency, and a foreign exchange rate is the exchange rate between these two currencies. As we can see easily from the equation, the exchange rate is the relative price of the good in the home and foreign country. Although the PPP approach is a

reasonable explanation for the determination of exchange rates, it is not complete since it neglects transportation costs, tariffs, and other trade barriers. Also, it assumes all goods are traded internationally. Because of these disadvantages of the PPP approach, a more general version of it, called absolute purchasing power parity, was introduced. Absolute PPP takes into account only price levels and not the domestic and foreign price of a good. Although P^D and P^F in Equation (2.6) define consumer price indices in the home and a foreign country, respectively, in this approach, the logic is the same as in previous one. Therefore, the absolute PPP approach also neglects transportation costs, tariffs, and so on just as the standard PPP approach does. Since it is not possible to carry a good from one place to another one without any transportation costs or differentiations among the goods and good baskets in different countries, it is therefore difficult to state that absolute PPP approach will hold. A more general version of the PPP approach, relative purchasing power parity, gives a more reasonable explanation for determination of exchange rates. Basically, it argues that increases in exchange rates are reflected by increases in the differences between domestic and foreign price indices. Equation (2.6) formulates the theory of relative purchasing power parity, where and P^D and P^F are domestic and foreign consumer prices indices, respectively:

$$\frac{P_t^D}{P_{t-1}^D} = \left(\frac{E_t}{E_{t-1}}\right)\left(\frac{P_t^F}{P_{t-1}^F}\right) \qquad (2.6)$$

where P_t^D and P_t^F are domestic and foreign consumer price indexes (CPIs), respectively, at time *t*, and E_t is the exchange rate as of time *t*. The time index *t – 1* indicates the value of the price or exchange rate in the time period immediately prior to time *t*.

2.3.2 The Balance of Payment (BoP) Approach

The balance of payment is a method of recording all international money transactions of a country during a specific time period. The balance of payment includes *current account, capital account,* and *the central bank transactions* sections. The current account is formed by exports and imports of goods and services and transfers, while the capital account contains the portfolio and direct investments. Increases or decreases in foreign reserves are related to central bank transactions. According to the BoP approach, any change in exchange rates results from inflows or outflow in the balance of payment. Thus, the equilibrium exchange rate is determined by foreign currency inflows and outflows in the current account being balanced by foreign currency inflows and outflows in the capital account.

Before and also during the Bretton Woods system, the BoP approach was commonly used to explain determinants of exchange rates. After the breakdown of Bretton Woods, the portfolio

balance and the monetary approaches became more popular, and the BoP approach was considered less significant by researchers.

2.3.3 The Monetary Approach

Among economists, monetarism began to be popular in the 1970s, and common acceptance of the monetarism approach encouraged many economists to think that exchange rates were determined by supply and demand for domestic and foreign money or government bonds. In other words, the monetary approach argues that changes in exchange rates can be explained by changes in supply and demand for the money in the domestic and international markets. To better understand this approach, we can consult both of the quantity theory of money and purchasing power parity. As we can see from equation (2.7), the quantity theory of money argues that there is a strong relation between quantity of money and price levels. Thus an increase in the money supply leads to higher inflation and higher inflation depreciates the value of domestic money, resulting in purchasing power parity[3]:

$$M \times V = P \times Y \tag{2.7}$$

where M is the money supply, P is price level, Y is the real gross domestic product (GDP), V is the velocity of money,

In the international context, this relation implies that an increase in money supply leads to higher inflation and lowered purchasing power parity, resulting in depreciation of exchange rates.

2.3.4 The Portfolio Balance Approach

The portfolio balance approach presents theoretical background for the portfolio balance channel through which sterilized interventions can influence the exchange rates. This approach is based on the assumption that investors diversify their portfolio assets to reduce risk by investing among different financial assets and also by investing in other countries. Investors invest in domestic and foreign money and bonds. Since any factor that changes distribution of the investments requires the investors to balance among their investments, changes in exchange rates result. For example, any change in the current account leads to changes in the distribution of investors' portfolios. Then, investors try to achieve re-balance between foreign and domestic assets. During the balancing process, changes in the exchange rate occur and directly influence foreign trade,

[3] The formula in equation (2.7) was first introduced by Irving Fisher and was then developed by Milton Friedman. It describes the relation between domestic money supply and price levels.

and thus the current account. This reciprocal influence between current account and exchange rate continues until the exchange rate reaches an equilibrium point.

The portfolio balance approach also assumes that domestic and foreign assets are not perfect substitutes for each other since they have different risk premiums and they provide investors with different returns. Therefore, risk-averse investors will redistribute their portfolios among domestic and foreign assets when a change in the expected return and risk of the domestic and foreign assets occurs. This redistribution of the portfolio investments leads to further changes in exchange rates. As an example of sterilization, when monetary authority in a country decides to sell domestic government bonds and buy domestic currency from the public to sterilize the impact of a foreign exchange buying intervention. It will result in domestic interest rates increasing and it will induce investors to buy more domestic bonds rather than foreign assets, resulting in depreciation of domestic currency.

2.4 Channels of Foreign Exchange Interventions

As we have already mentioned, there is a consensus regarding the impact and efficiency of nonsterilized interventions, whereas the efficiency of sterilized interventions is a controversial issue among economists. Doubt remains as to whether sterilized interventions can influence exchange rates in any meaningful way except through such channels as signalling; the portfolio-balance channel is mostly accepted. Furthermore, Hung (1991 and 1997) postulated a new channel called noise-trading.

2.4.1 Portfolio-Balance Channel

Interventions may work through a portfolio-balance channel based on assumptions of the portfolio-balance approach. According to this approach, investors allocate their portfolios to balance exchange rate risk against expected rate of returns (Aguilar & Nydahl, 2000). In other words, investors diversify their portfolios amongst foreign and domestic assets based on expected return and on the variance of returns (Dominguez, 1998). Thus, a portfolio balance channel can only work if domestic and foreign assets are assumed as unable to substitute for each other. If they are perfect substitutes, investors will care only for the amount of total assets they owned instead of caring about the ratio of domestic and foreign assets to balance their portfolios. Therefore, portfolio-balance channel theory claims that these cannot be substituted for each other because of the exchange rate risk. For this reason, investors require a risk premium to hold a foreign asset. After interventions, since central banks will buy or sell domestic assets as part of a sterilized intervention, it will result in changes of supply of foreign and domestic assets in the

investor's portfolio and so also change the existing balance in the portfolio. When investors try to create a balance among foreign and domestic investments in their portfolios, risk premiums will change, leading to changes in exchange rates.

On the other hand, finding in previous studies disagree with respect to crucial assumptions in portfolio-balance theory as to foreign and domestic assets being perfect substitutes. Mussa (1979) contends that they can be substitutes whereas some other studies, such as Obstfeld (1990), provide supporting evidence for portfolio-balance theory. Schwartz (2000) states that there is no consensus regarding this assumption.

2.4.2 Signalling Channel

Whether domestic and foreign assets are perfect substitutes or not, sterilized interventions can impact on ER through a signalling channel (Mussa, 1981). The signalling channel is based on the assumption that central banks use foreign exchange market interventions to convey information about economic fundamentals to market participants. If market participants see interventions as signals indicating that, although today's fundamentals do not change, future fundamentals are expected to change. This expectation leads market participants to revise their expectations of future spot exchange rates (Dominguez, 1998). In other words, intervention is used as a signal to give investors information regarding future monetary policy, which changes their expectations with regard to future policies. Thus, by changing expectations, central banks aim to influence exchange rates (Sarno and Taylor, 2001).

The size of the impact of a sterilized intervention on ER through the signalling channel may exceed that of a nonsterilized intervention, depending on the nature of information the signal is meant to convey (Dominguez, 1998). If the intervention signal is credible and clear and if foreign exchange markets are efficient, interventions reduce volatility of foreign exchange rates or, at the very least, fail to influence variances in foreign exchange rates (Dominguez, 1998). For instance, under these assumptions, an official intervention which is intended to convey a message about future contradictory monetary policy leads to the appreciation of the domestic currency without any impact on foreign exchange rate variance. In another scenario, it would result in a decrease in volatility of foreign exchange rate without impacting the level of foreign exchange rates. On the other hand, if it is not credible or is ambiguous, volatilities in foreign exchange rates will increase due to uncertainty (Dominguez, 1998). In recent years, the reason that central banks do not usually use secret interventions may be due to the desire of using signalling channel to influence foreign exchange rates (Agcaer, 2003).

2.4.3 Noise-Trading Channel

Hung (1997) introduced a new channel that he termed *noise-trading* for central bank interventions to affect ERs. The term, noise-trading, comes from the concept of noise trader first introduced by Kortian (1995), who defined a noise trader as a speculator in financial markets whose demand for currencies or any other assets is influenced by beliefs and sentiments which are not consistent with any economic fundamentals and theory. Hung (1997) states that central banks induce a noise trader to buy or sell a currency by entering a thin market. Hung argues that sterilized intervention may cause changes in speculators' perception regarding a current trend in exchange rate movements; specifically, they can begin to view existing movements in foreign exchange rates as a reversal as they start to take the same position with intervention against a particular currency. Therefore, effects of sterilized interventions on ERs can be longer and larger than usual sterilized interventions.

The crucial point for using noise-trading channels is that central banks must be familiar with the reaction functions of speculators, and interventions should be implemented secretly by central banks.

Chapter 3

The Interventions in Advanced and Emerging Market Economies

3.1 Advanced Economies

During the Bretton Woods system, values of the currencies of member countries were determined in a fixed regime, and interventions were required when rates exceeded their pre-determined parity bands (Dominguez, 1993). But in the period after the collapse of Bretton Woods, developed countries began to implement floating exchange rate regimes without interventions, or, stated in another way, intervention policy was left to the discretion of individual countries (Dominguez, 1993). Although under the floating exchange rate regime, we can expect that rates would be determined by supply and demand in international markets, most of the countries used interventions to impact value of their national currencies. In 1977, the IMF Executive Board provided its member countries with three principles intended to advise them regarding the usage of intervention policies. The first principle stated that countries should not manipulate exchange rates to gain unfair competitive advantage or prevent balance of payment adjustments; rather, they should use intervention policies to calm a disorderly foreign exchange market, and countries should respect the interests of other countries with respect to exchange rate.[4] These principles imply that countries can use intervention policies to reduce exchange rate volatility.

During the 1970s, interventions in foreign exchange markets were observed frequently because high volatilities in ERs began to be observed. They were even higher than what policymakers and other market participants expected under the floating exchange rate regime. Then, in the beginning of the 1980s, as a result of the common view among policymakers, economists and other market participants concluded that intervention (especially sterilized intervention) is not an effective policy and has only a temporary effect on exchange rates. The U.S. stopped intervention in foreign exchange markets during 1981-1984. On the other hand, during the years in which U.S. policymakers abandoned interventions, other developed countries such as West Germany, Japan, and Canada continued to intervene in foreign exchange markets.

[4] IMF executive Board Decision no. 5392-(77/63), adopted April 1977.

In the middle of 1985, the U.S. dollar appreciated by 40% against the mark and the U.S. trade deficit was about $100 billion. As a result of the 1985 G5 meeting, by an agreement known as the Plaza Agreement, the U.S. started to use interventions along with other G5 countries to depreciate the U.S. dollar. In 1986, against excessive depreciation of the dollar, the BOJ began to intervene to support the U.S. dollar. In the following year, 1987, the G7 countries decided to implement coordinated multilateral policies known as the Louvre Accord to reduce the high volatility of the U.S. dollar and restore equilibrium in current account balances (Baillie & Posterberg, 1997). During the 1990s, in advanced economies with the exception of Japan, there was a decreasing trend in the usage of foreign intervention policy relative to 1980s because of the new stability in exchange rates. The Bundesbank, which was one of the most active institutions in intervention operations during the 1980s, continued to intervene with great frequency until 1992. After that, the Bundesbank rarely tried to influence exchange rates and abandoned the practice of intervention as did U.S policymakers after 1995. The Bank of England also ceased interventions in 1993. Another developed country, Canada, stopped participating actively in the foreign exchange market. On the other hand, BoJ remained active in the foreign exchange markets by buying large volumes of U.S. dollars during the 1990s. In 1999, the European Central Bank was founded, and it became the leading authority regarding monetary decisions. In the same year, after the establishment of the new currency, the euro, excessive depreciation in the euro was observed. At this time, developed countries took joint actions to protect the value of the euro. During the 2000s, we rarely see foreign exchange interventions by central banks of industrialized countries, excluding Japan and the Swiss National Bank.

3.2 Emerging Market Economies

Nowadays, central banks in emerging countries frequently intervene in foreign exchange markets even when the amount of the intervention is large. Because of increased capital movements and especially rapid changes in capital over short time periods and increase in volume of global exchange markets, policymakers in emerging countries are more cautious to alleviate possible negative impacts on the economy such as uncertainty and high volatilities in exchange rates. The stability of exchange rates is still an important topic in the countries that lack credibility because of high-risk premiums when exchange rates are considered as an asset price. Furthermore, the stability of exchange rates influences the macro-economy of a particular country through various channels: Firstly, exchange rates can affect import prices and can therefore influence inflation via a pass-through mechanism. Also, since the exchange rate impacts export volume, it implicitly also influences growth and unemployment. Central banks which aim to reduce negative effects of short-term capital movements are forced to increase foreign currency reserves (Yeldan, 2001).

As a result, nowadays while developed countries that have efficient and credible markets rarely use intervention policy, developing countries frequently use interventions as a policy tool in foreign exchange markets. According to the literature (Canales-Kriljenko 2003, Table 2), in an IMF survey among the non-developed countries which are members of IMF, 91% of the participant countries declared that they intervened in foreign exchange market. Also, according to IMF (2010, pg. 24), 65% of its member have some sort of intervention data as proof of intervening in exchange markets.

Beside the fact that nowadays frequency and importance of interventions in emerging countries are higher than their usage and importance in advanced economies, Canales-Kriljenko (2003), based on the IMF's 2001 Survey on Foreign Exchange Market Organization, suggests that interventions made by central banks in emerging economies are more effective than interventions by central banks in advanced economies. Caneles-Kriljenko (2003) states some possible reasons for the fact above: First of all, unlike central banks in developed countries, central banks in emerging market economies sometimes do not sterilize their foreign exchange market interventions. Since previous studies showed that nonsterilized interventions influence exchange rates, we can expect that in those countries where interventions are not sterilized, foreign exchange interventions are effective. Also, institutional environments of the emerging or undeveloped countries where interventions occur are different from the ones in advanced economies. Central banks in emerging market economies have better conditions to control their exchange market because of their sheer size (Menkhoff, 2012). In advanced economies, especially in countries where three major currencies (USD, EUR, and JPY) are issued, even though central banks' interventions are made in huge amounts in terms of absolute values, they still remain small with respect to total foreign exchange market turnover. However, in emerging market economies, central banks can conduct foreign exchange interventions in amounts that are important relative to total size of the foreign exchange market, the money base, and the stock of domestic bonds outstanding (Canales-Kriljenko, 2003). Moreover, unlike central banks in developed countries, central banks in some developing countries have a greater information advantage regarding the aggregate foreign exchange order flow through reporting requirements. In addition, central banks in such countries use foreign exchange and monetary regulations to increase their information advantage. Lastly, moral suasion can be used to increase the impacts of the interventions on exchange rates in emerging market economies. Agcaer (2003) also mentions that in developing countries, central banks generally are authorized to manage and control foreign exchange market transactions. They choose who will participate in exchange transactions under specified laws and regulations. Additionally, they oversee the actions made by market participants, and if a central bank views it as necessary, can remove market participants

or suspend the actions of a market agent. Therefore, foreign exchange interventions are effective and more important in an emerging country.

Chapter 4
Turkish Economy

In this chapter, as we present a brief history of monetary policy and exchange rate regimes in Turkey, we will be analyzing macroeconomic conditions and changes which led to crises and changes in policy and regimes in that country. Then, we will focus on the monetary policy of the Central Bank of the Republic of Turkey (CBRT) and activities including monetary policy decisions and foreign exchange rate interventions during our study period of 2005 to 2012.

4.1 The Recent History of the Turkish Economy

Until ten years ago, the Turkish economy was characterized by persistent high inflation. During the years preceding 2000, unstable growth performance, huge public deficits, and short-term capital flows attributable to political instability were observable. In addition, the importance of monetary policy was underestimated and fiscal policy prevailed for the public-sector borrowing requirements of the government. Under these circumstances, exchange rates tended to increase and fluctuate due primarily to high inflation. These were the main reasons for the occurrence of serious crises during the 1990s and the early 2000s. The Turkish economy suffered from serial financial and currency crises, such as that of 1994, resulting from the effects of the Asian and Russian crisis. The crises of November 2000 and February 2001 were the last and led to radical changes in both monetary policy and exchange rate regime.

During the 1990s, the macroeconomic environment of Turkey was shaped by high levels of inflation and unstable economic growth, since the main source of external finance for the government consisted of short-term capital flows. Furthermore, the banking sector, and in fact the entire financial sector were regulated insufficiently and were therefore vulnerable to rapid changes in capital movements. In addition to these weaknesses of the economy, the political system was also marked by instability, which further aggravated the economic situation. During the first half of the 1990s, CBRT pursued monetary targeting as a main policy under a crawling peg exchange rate regime. However, these circumstances led to a serious currency crisis in 1994, which resulted in devaluation of TRY against the USD by more than half. After the 1994 crisis, CBRT's official monetary policy was still to sustain monetary and financial stability. In the years between 1995 and 1999, the exchange rate regime conducted by CBRT focused on achieving stability in financial markets (Gormez & Yilmaz, 2007). For this purpose, the crawling peg

regime was replaced by a managed float regime in which CBRT conducted an increasing number of interventions in the foreign exchange market.

Since, in the period following 1999, volatility of exchange rates together with persistent high level of inflation continued, the CBRT has focused primarily on the issue of inflation and volatility of exchange rates. Therefore, the CBRT planned to execute a three-year stabilization program supported by IMF in 2000. During the next three years, the main task of the CBRT would be to support this program, which was called Exchange Rate Based Stabilization (EBRS) Program. The aim of the EBRS Program was to achieve price and exchange rate stability. For this purpose, in 2000, the exchange rate basket was announced on a daily basis along with a Stand-by-Agreement with IMF. The exchange rate regime was transformed from managed floating to a sort of crawling peg regime, tablita regime, where daily announcement of the exchange rate basket was viewed as an anchor for inflation expectations. But, following the two financial crises in November 2000 and February 2001, policymakers decided to abandon the EBRS Program due to the rising costs of the pre-announced exchange rate regime was increasing. Gormez & Yilmaz (2007) list the reasons for this failure as follows:

- Flaws in structure and arrangement of the stabilization program
- Failures in execution of necessary reforms
- Failure in execution of tight fiscal policy
- Delays of privatizations
- The strength of the USD against the EUR
- Jump in oil prices

After the financial crisis of February 2001, a new economic program called Transition Strong Economy Program was launched along with structural reforms aimed at reducing uncertainties in the financial markets and rebuilding financial and banking sectors. After the crisis, while monetary policies were also being switched to inflation-targeting ones, the main goal of CBRT was determined to be achieving and maintaining price stability. Also, CBRT decided to let exchange rates float. Under a floating exchange rate regime, through the new stabilization program, policymakers intended to stabilize the whole economy by decreasing inflation so as to achieve fiscal austerity together with a viable debt position and to have sustainable growth (Ozturk, 2006). Along with the floating exchange rate regime, CBRT stated that it would not affect the level of the exchange rate or change the long-run equilibrium levels of exchange rates and that it would intervene in foreign exchange markets only if excessive volatility were observed. In the period following 2001, discretionary interventions and foreign

exchange auctions have become the main tools in executing exchange rate policies.[5] After February 2001, CBRT took several consecutive actions. First of all, it provided the banks with liquidity in terms of foreign currencies by employing methods of swap or direct selling foreign exchange currencies against TRY so that banks could meet their financial obligations and cover their short positions. At the end of March 2001, after March 29, CBRT started to conduct pre-announced (time and amount of the auction announced beforehand) selling auctions through which it aimed to smooth excessive short-term exchange rate fluctuations without affecting long-run equilibrium levels of exchange rates and to increase the transparency of foreign exchange sale transactions . During 2001, in total, US$ 6.5 billion were sold by the CBRT. In this same year, CBRT conducted only one buying auction, which was worth only US$ 47 million.

By the beginning of 2002, an implicit inflation-targeting regime was implemented by CBRT and left in place until 2006 and short-term interest rates were employed as a monetary policy tool for the purpose of achieving price stability. Under the floating exchange rate regime, achieving exchange rate stability with minimum central bank interventions is a crucial target for inflation-targeting regimes (Ozturk, 2006). That is the main reason that CBRT conducted discretionary foreign exchange interventions at only three times in 2002 during which CBRT changed the form of the auctions from selling to buying. Although they were suspended from July 2002 to May 2003 because of political uncertainty, buying auctions became the primary tool with which CBRT intervened in foreign exchange markets. The buying auctions were motivated mostly by reverse currency substitution and increasing amounts of capital inflows. The buying auctions were conducted to serve the purpose of international reserve accumulation. During 2003 and 2004, CBRT continued to conduct discretionary interventions and auctions only in the form of purchase, except for a small number of selling interventions during May 2004. Table 4.1 provides a summary of the CBRT's intervention transactions during the post-crisis period, including both discretionary interventions and pre-announced auctions.

[5] Interventions and auctions are conducted only in terms of USD in Turkey.

Table 4.1: CBRT's 2002-2004 Discretionary Interventions and Foreign Exchange (FX) Auctions in Millions USD)

Year	FX Buying Auctions	FX Selling Auctions	FX Buying Interventions	FX Selling Interventions	Total Net FX Transaction
2002	795	-	16	12	+799
2003	5,652	-	4,229	-	+9,881
2004	4,104	-	1,283	9	+5,378
Total:					**+16,058**

Source: Central Bank of the Republic of Turkey

The overall economic policy implemented by policymakers for the post-crisis period has been successful: First, the Turkish economy began to recover and then showed significant growth performance. Inflation rates showed downward trends. In this respect, we could say that the inflation-targeting policy was implemented successfully. Thus, the effectiveness of the monetary policy was improved without any pre-determined exchange rate targets. The public debt to GDP ratio also decreased. Following these positive impacts on the economy, especially the decreases in inflation, the dollarization effect through Turkish economy also declined (Ozturk, 2006), resulting in a decline in exchange rate pass-through impacts on domestic price levels. Therefore, new conditions determined further monetary policy decision making, including the exchange rate policy which began to adjust to the variation in both domestic and international markets (Ozturk, 2006).

4.2 Monetary and Exchange Rate Policies between 2005-2012

Since our study period covers the days between January 4, 2005 and December 31, 2012, we will focus on monetary and foreign exchange rate policies in the period between the years 2005 and 2012. In this section, we will also present detailed information regarding interventions and auctions conducted during this study period.

In 2005, CBRT continued to implement implicit inflation targeting with a floating exchange rate regime. With the success of a stabilization program launched following the February 2001 crisis, the dollarization effect on the economy declined, resulting in

improvements in balance of payments together with an increasing supply of foreign currency while demand for foreign currency did not increase at the same rate or even declined.[6]

Under the floating exchange rates, since equilibrium levels of exchange rates are determined by supply and demand of the market participants for foreign currencies, level of international reserves becomes unimportant. However, in economies, where government and private sectors hold huge amount of foreign currency debts, having a strong position in terms of international reserves can protect an economy from the negative effects of external shock or even internal shocks. Another reason for having high levels of international reserves is that having a good position in international reserves is viewed as increasing the credibility of the country. Therefore, CBRT pursued a moderate reserve accumulation policy. For this purpose, it started to conduct buying auctions in 2002 and continued in 2003, in 2004, and in 2005 as well. The total number of foreign exchange buying auctions in 2005 was 242, and these totaled US$ 6,900 million. Under this moderate reserve accumulation policy, CBRT states that foreign exchange buying auctions are conducted only in times when increases in supplies of foreign currency are higher than increases in demand for this foreign currency. But, CBRT states that it does not have any target for exchange rate levels under the floating exchange rate regime. CBRT also states that it monitors foreign exchange markets and pays close attention to excessive volatility in exchange rates. Thus, it states, buying auctions can be suspended when excessive volatilities of exchange rates or unusual prices are observed in foreign exchange markets because of external shocks or unexpected events. In addition, whenever excessive volatility is observed, CBRT would directly intervene with purchases or sales to eliminate excessive fluctuations in exchange rates. CBRT conducted six foreign exchange buying interventions during 2005 totaling US$ 14,565 million. There were no foreign exchange selling interventions or auctions in 2005.

In 2006, after the necessary conditions of a strong financial system and lowered inflation rates, which eliminated concerns about consistent fiscal discipline in fully implementing inflation targeting, were achieved, CBRT replaced the implicit inflation-targeting regime implemented in 2002 with explicit inflation targeting. As in previous years, CBRT allowed the exchange rates to float. In a nutshell, the main policies regarding the interventions and auctions remained same. In the first months of 2006, CBRT continued to conduct pre-announced buying auctions. But, since excessive volatility was observed along with a disappearance of thickness in the foreign exchange markets on May 16, foreign exchange buying auctions were suspended till November 10. The total number of buying auctions in 2006 was 121. Also, CBRT conducted one buying intervention and three selling interventions to eliminate excessive volatilities in foreign exchange

[6] CBRT Monetary and Exchange Rate Policy for 2005 no.2004-59, December 2004

rates. In addition to three selling intervention, after 2001 the first exchange rate selling auctions were conducted. CBRT conducted two selling auctions, each in the amount of US$ 1,000 million.

During the period between 2007 and 2010, there were no any monetary and exchange policy changes in Turkey. CBRT continued inflation-targeting as a monetary policy with the floating exchange rate regime. From 2007 to 2010, CBRT did not conduct any direct interventions while it used many foreign exchange auctions for very large amounts. The main reason for conducting foreign exchange buying auctions was a moderate reserves-accumulation policy under suitable conditions. The number of foreign exchange buying auctions was 240, 194, 97, and 238 through the years 2007, 2008, 2009, and 2010, respectively. Total amount of foreign currency purchased through foreign exchange buying auctions between 2007 and 2010 was US$ 35,921 million. During this time, gross foreign currency reserves were increased from US$ 63 billion to US$ 86 billion. But, in 2008 with the appearance of effects attributable to the global financial crisis, CBRT started to take precautions to alleviate the negative impacts of the crisis. For this purposes, it firstly decreased the amount of foreign currency purchased at auctions. Later, from October 2008 to August 2009, these buying auctions were suspended. By the beginning of August 2009, because of optimistic expectations regarding the global economy, recovery of liquidity conditions and an increase in risk seeking led to returning increases in capital flows to Turkey as in other emerging market countries. Besides increases in capital inflows, FX markets seemed to be again stable, and so, CBRT decided to again conduct buying auctions. Furthermore, between 2007 and 2010, CBRT continued to monitor foreign exchange markets closely as a general foreign exchange rate policy. In 2008 and 2009, CBRT employed selling auctions to forestall the negative effects of the global crisis by providing foreign currency liquidity. In October 2008, CBRT conducted two selling auctions which totaled US$ 100, and, from March to April 2009, 18 additional selling auctions were conducted totaling US$ 900. As a result of positive signs regarding recovery of the global economy, these were ended on April 2, 2009.

In 2011, under the floating exchange rate regime, CBRT continued to intervene in foreign exchange markets through foreign exchange buying and selling auctions. By the beginning of October 2010, CBRT had started to employ a flexible foreign exchange buying auction method under which CBRT abandoned the application of optional purchases. As a result of increasing concerns regarding sovereign debts of some European countries, capital inflows to emerging countries were reduced. Thus, CBRT firstly decreased gradually the amounts of foreign currency purchased by the auctions. Then, CBRT ceased buying auctions in July 2011 because of the

effects of the sovereign debt crisis in Europe. By August 2011, CBRT started to conduct foreign exchange selling auctions to ensure that foreign exchange markets worked properly with sufficient liquidity conditions. Also, CBRT intervened directly in foreign exchange markets in the form of sales after speculative transactions due to lack of market density were observed. CBRT continued to conduct both foreign exchange selling auctions and selling interventions in the first month of 2012, but did not use any foreign exchange buying transaction during this year.

As a general framework regarding monetary and exchange rate policy between 04.01.2005 and 31.12.2012, we can conclude for the following:

- CBRT pursued an inflation-targeting regime as a monetary policy along with the floating exchange rate regime. In a floating exchange rate regime, exchange rates were employed neither a target nor as a policy tool. CBRT's only target was inflation, and for this purpose short-term interest rates were employed.
- Exchange rates are determined by supply and demand conditions in the foreign exchange market. Both supply and demand for foreign currencies are determined mainly by fiscal and monetary policies implemented, economic fundamentals, and international shocks or expectations.

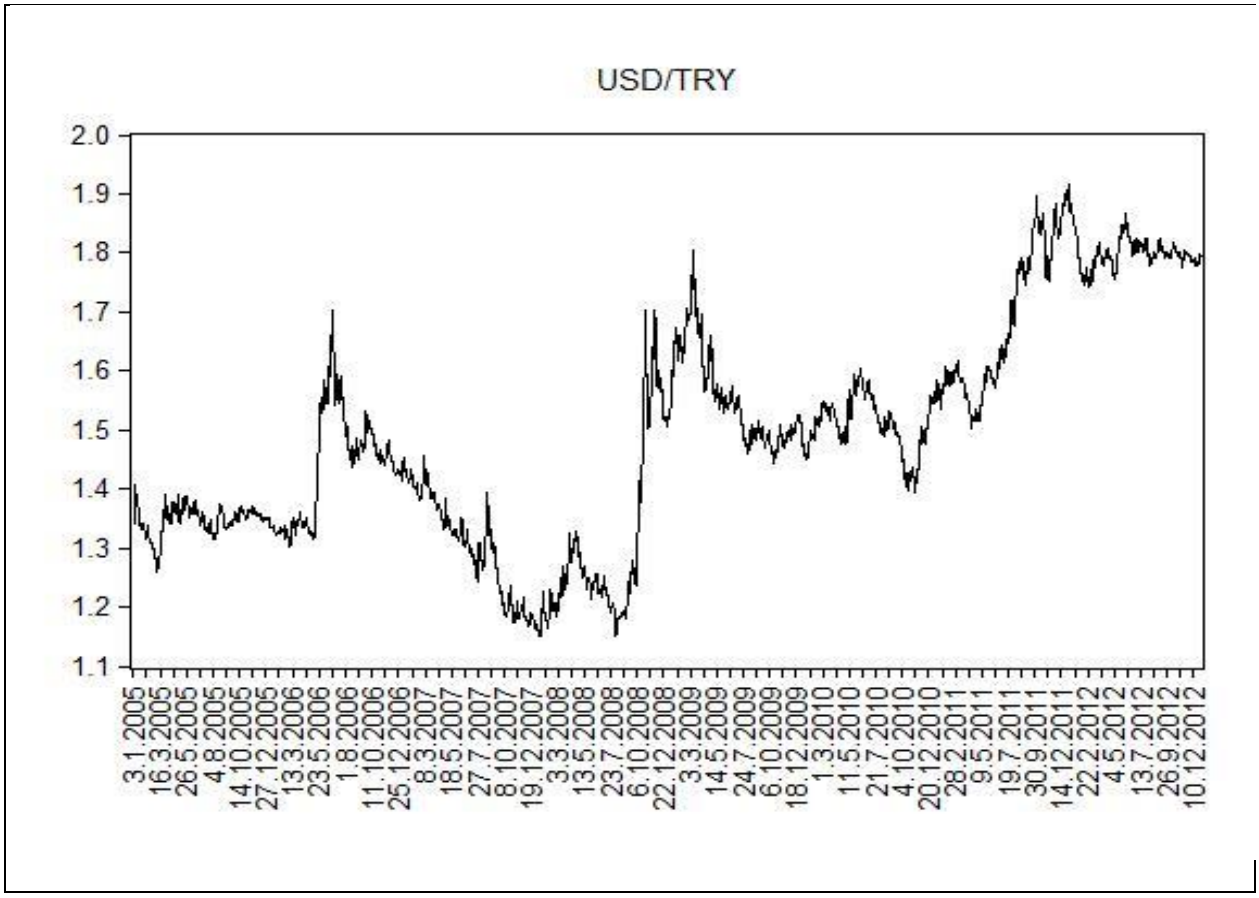


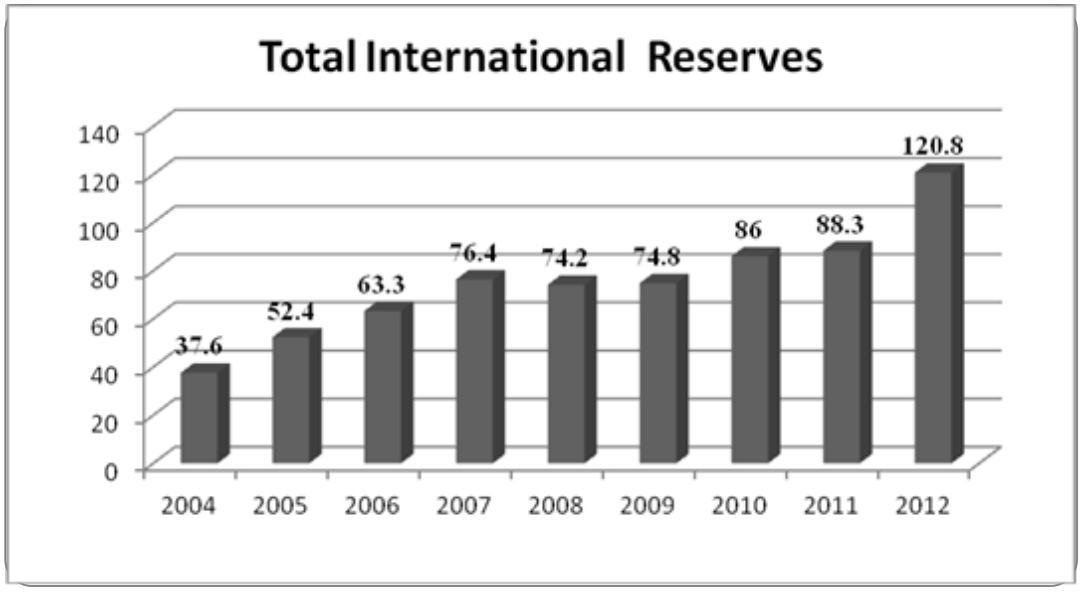
Figure 4.1: USD/TRY Exchange Rates (2005-2012)

Source: Central Bank of the Republic of Turkey

As we can see from Figure 4.1, USD/TRY exchange rates were depreciated before the appearance of negative effects attributable to the global crisis. By the end of July 2008, the TRY suddenly started to lose its value against the USD. After that, the period between March 2009 and May 2011 was relatively stable. But, after July 2011, TRY started to depreciate again against the USD until the end of 2011. By the beginning of 2012, USD/TRY foreign exchange rates depreciated and then became relatively stable during the year.

- Although there is no any target for an equilibrium level of exchange rates, having sufficient international reserves alleviates negative impacts of unexpected events or shocks. Also, having a strong position in international reserves increases accountability of countries such as Turkey. Therefore, CBRT pursued a moderate

reserve accumulation policy. For this purpose, CBRT conducted pre-announced foreign exchange buying auctions whenever supply of foreign currencies was relatively higher than demand for them.



Source: Central Bank of the Republic of Turkey

Figure 4.2: CBRT's Gross International Reserves (including Gold Reserves, 2005 -2012; billion USD)

As we can see from Figure 4.2, CBRT had increased its international reserves from US$ 37.6 to 120.8 billion by December 21, 2012. One of the main tools for this reserve policy was foreign exchange buying auctions. Between 2005 and 2012, CBRT purchased a total of US$ 54.8 billion solely through buying auctions. The point is that CBRT's international reserves remained almost the same during the crisis periods such as the global crisis occurring between 2007 and 2008 and the 2009 European debt crisis.

- CBRT also conducted pre-announced foreign exchange selling auctions whenever unusual prices emerged depending on lack of market density.
- CBRT stated that it closely monitors the foreign exchange markets and that it would intervene directly when foreign exchange rates become excessively volatile.

Table 4.2: Direct Interventions (Between 2005 and 2012, million USD)

Date	FX Buying Interventions	FX Selling Interventions
27.1.2005	1,347	-
09.03.2005	2,361	-
03.06.2005	2,056	-
22.07.2005	2,366	-
04.10.2005	3,271	-
18.11.2005	3,164	-
15.02.2006	5,441	-
13.06.2006	-	494
23.06.2006	-	763
26.06.2006	-	848
18.10.2011	-	525
30.12.2011	-	1,865
02.01.2012	-	525
03.01.2012	-	326
04.01.2012	-	155
Total:	**20,006**	**5501**

Source: Central Bank of the Republic of Turkey

Table 4.3: CBRT's Discretionary Interventions and Foreign Exchange (FX) Auctions (2005-12; million USD)

Year	FX Buying Auctions	FX Selling Auctions	FX Buying Interventions	FX Selling Interventions	Total Net FX Transaction
2005	7,442	-	14,565	-	+22,007
2006	4,296	1,000	5,441	2,105	+6,632
2007	9,906	-	-	-	+9,906
2008	7,584	100	-	-	+7,484
2009	4,314	900	-	-	+3,414
2010	14,865	-	-	-	+14,865
2011	6,450	11,210	-	2,390	-7,150
2012	-	1,450	-	1,006	-2,456
Total:					**+54,702**

Source: Central Bank of the Republic of Turkey

As we can see from Tables 4.2 and 4.3, CBRT conducted mostly purchase interventions or used foreign exchange buying auctions. The most frequently used tool was foreign exchange buying auctions during the period 2005-2012. In addition to number of usages, buying auctions

also dominated in amounts of US$. Especially, between 2007 and 2010, CBRT often conducted buying auctions whenever suitable market conditions prevailed. Also, while in the beginning of the study period, CBRT transactions in the form of purchases were dominant, at the end of the study period, both foreign exchange selling interventions and foreign exchange selling auctions prevailed.

Chapter 5
Literature Review

In this chapter, we will discuss findings of previous studies. Since many studies have been performed regarding central banks' foreign exchange interventions, we divided and evaluated them according to purpose. Later on, we will briefly discuss studies concerning interventions in emerging countries and then present findings of studies that focused on CBRT interventions in Turkey.

5.1 Studies on Channels of Foreign Exchange Interventions

Broadly, studies that focused on channels of foreign exchange interventions concern portfolio-balance and signalling channels.

Studies in the 1970s and 1980s based on a portfolio-balance channel failed to detect statistical significance in the effects resulting from sterilized interventions. For instance, Henderson (1984) and Rogoff (1984) found no evidence to show that central bank interventions influenced foreign exchange rates through portfolio channel. Lewis (1988) also failed to show any significant impact of sterilized intervention on foreign exchange rates. The studies that do show a statistically significant impact conclude that this impact is small and temporary (Gosh, 1992). The reason for these failures to show a statistically significant impact resulting from sterilized interventions via a portfolio-balance channel can be explained by the tremendous daily volume of foreign exchange. Thus, central banks cannot perform enough interventions to affect foreign exchange rates through the portfolio-balance channel (Froot& Obstfeld, 1989). However, studies in the 1990s showed some positive results in favor of a portfolio-balance channel. For example, Dominguez & Frankel (1993) show that US Federal Reserve Bank and Bundesbank interventions achieved effectiveness during the 1980s using a portfolio-balance mechanism.

Also, many studies in the literature have been devoted to signalling channel. One is that of Dominguez (1992), who tried to discover whether or not 1977-1981 Fed interventions conveyed a message regarding future monetary policies or not. According to the study results, only some interventions in those years could be viewed as signals. Moreover, Kaminsky & Lewis (1993) failed to detect a relation between Fed interventions during the period from 1985 to

1990 and monetary policy during the same period. Fatum & Hutchison (1996) also suggest that Fed interventions do not include any message regarding monetary policy, even though they lead to higher volatility of foreign exchange rates. However, Hopkins & Murphy (1997) concluded that interventions performed by the Reserve Bank of Australia conveys signals regarding future possible changes in monetary policy. Another study, Dominguez & Frankel (1993), presents results indicating that interventions change expectations and can therefore impact foreign exchange rates. Similarly, Beine et al. (2002) reach the same conclusion with respect to the impact of interventions on expectations of market participants.

5.2 Studies on Efficiency and Effects of Interventions on Foreign Exchange Rates

Klein & Rosengren (1991) based their study on signalling hypothesis and suggest that effects of interventions on foreign exchange rates are transitory. Dominguez & Frankel (1993) base their study in a period from 1982 to 1988 and used simultaneous equations and regression models. They found that unexpected interventions are more effective on foreign exchange rates. Baillie & Osterberg (1997) analyzed Fed and Bundesbank interventions between 1985 and 1990 using the MGARCH model and failed to detect any significant impact of interventions on foreign exchange rates. Beine et al. (2002) studied Fed, BoJ, and Bundesbank interventions during 1985-1995 and use the FIGARCH model. They found that buying interventions causes depreciation in foreign exchange rates. Fischer & Zurlinden (1986) studied interventions in Switzerland and suggest that interventions influence foreign exchange rates for a short time. In case of Japan during 1991-2000, Fatum & Hutchinson (2006) suggest that sterilized interventions affect short-term foreign exchange rates but when interventions occur simultaneously with changes in interest rates, the effects of intervention disappear.

5.3 Studies on the Relation between Foreign Exchange Volatility and Interventions

Dominguez (1993) studies a period during 1985-1991 by employing GARCH models and shows that interventions of the Fed which are publicly known reduce volatility of foreign exchange rates while secret interventions increase volatility. Dominguez (1998) reached the same conclusion as the result of a study on 1977-1994 interventions of FED, Bundesbank, and BoJ. Bonser & Tanner (1996) tried to find a relationship between intervention policies of these same countries and volatility but for a different period, 1985-1999. Their findings show that

interventions increase volatility of foreign exchange rates. Chang & Taylor (1998) employed ARCH models for the case of Japan during 1992-1993 and found that effects of interventions are strong but short-lived and also causes volatility. Beattie & Fillion (1999) performed their study on Canada in the period between 1995 and 1997. They used GARCH and regression models. Their conclusions regarding interventions of the Bank of Canada were similar to those of Dominguez (1993). Thus, secret interventions have been shown to cause volatility while interventions which are publicly known have no impact on volatility. Galati & Melick (1999) suggest that interventions increase uncertainty regarding future exchange rates and therefore increase volatility of foreign exchange rates. Payne (2003) used an event study approach to show that interventions affect volatility and suggests that market participants respond to reported interventions quickly. For Japan during 1991-2001, Nagayasu (2004) used GARCH models to show that interventions influence foreign exchange rates and that the size of this influence is enlarged when several central banks coordinate interventions. Dominguez (2006) employed MA-FIGARCH and ARFIMA models for interventions by FED, Bundesbank, and BoJ in the period between 1989 and 1995 and states that, although it is not clear whether interventions increase long-term volatility, strong effects of intervention on daily volatility of foreign exchange rates was detectable. Kim & Sheen (2006) used EGARCH models and suggest that efficiency of interventions can change from application to application, that coordinated interventions of two central banks are more effective, and that interventions not only increase volatility but also enhance volume of trade in the market. Hafner & Herwartz (2006) showed that exchange rate shocks enhance volatility of foreign exchange rates by using M-GARCH models for a period between 1979-1994 in the US, Germany, and the UK. Hwang & Stephen (2006) suggest that buying interventions are more influential on foreign exchange rates. Takeshi (2008) found that interventions reduce volatility, considered on a monthly base, using GARCH and EGARCH models for interventions of BoJ in the period 1991-2005. As opposed to other studies, Suardi (2008) used a TARCH model and suggested that direct interventions cause asymmetric volatility of foreign exchange rates.

5.4 Studies on the Determinations of Interventions and Volatility of Foreign Exchange Rates

Andersen et al. (2003) found a strong correlation between foreign exchange rates and news related to interventions, and they suggest that intervention news increases volatility of foreign exchange rates. Brandorff et al. (2006) suggest that foreign exchange variances stem from interventions and announcements made by policymakers. Beine et al. (2007) employed ARFIMA

models to analyze interventions of FED, Bundesbank, BoJ during the period 1985-2004. They found that coordinated interventions by several central banks not only lead to large changes in movements of foreign exchange rates but also enhance continuity of volatility of these rates.

5.5 Studies on Central Banks' Interventions in Emerging Economies

Even though foreign exchange interventions occur mostly in emerging countries, most studies have concerned intervention policies in advanced economies. Because of the different characteristics and properties of emerging countries with respect to exchange rate dynamics—such as having unstable foreign exchange markets, a fragile financial sector, an ambiguous relation between exchange and interest rates, and frequent currency crises do not allow researchers to analyze a particular emerging country's intervention policies (Akinci et al., 2005a). However, in recent years, most studies have paid more attention to emerging market economies and their central bank transactions, such as their intervention policies.

Unlike other studies, Scalia (2008) analyzes interventions in an emerging country, the Czech Republic, during a five-month period dating from July 2002 to December 2002. Through the use of simultaneous equation systems, interventions for depreciating CZK have become more influential. Another study of interventions of the Czech national bank is Disyatat & Galati (2007), which suggests that interventions during 2001-2002 had a significant but small impact on sports rates. Disyatat & Galati (2007) also employ an event study approach and regression models to analyze the effect of interventions performed by the Czech National Bank during the period 2001-2002. They could find no evidence short-term volatility of foreign exchange rates. Also they state that interventions in their study period were mainly employed against appreciation of the CZK.

Dominguez et al. (2010) analyzed implications of systematical reserve decumulation policy by Czech policymakers. Since reserve accumulation policy incurs the risk of valuation losses, Czech policymakers implemented systematic decumulation policy to mitigate valuation losses on euro-denominated assets. The study's findings showed the results of decumulation in everyday results in the appreciation of the Czech Koruna relative to the Euro. Thus, decumulation policy was shown to have an impact on domestic currency even though the policy was not intended to influence the value of the Koruna relative to euro.

Employing the GARCH model, Gersl & Holub (2006) did not find any level of impact on EUR/CZK foreign exchange rates and concluded that volatility increases after interventions. Behera et al. (2008) found that interventions reduce volatility while having no impact level on the foreign exchange rate of USD/INR. Employing dummy variables to define interventions, Goyal & Arora (2010) found that interventions reduce volatility while also having some level of impact on USD/INR.

5.6 Studies on Interventions in Turkey

The number of studies and researches on interventions in Turkey is limited. However, in the last ten years, studies have begun to pay more attention to efficiency of central bank interventions in Turkey as for other emerging market countries.

The first study for the efficiency of intervention in Turkey was Domac & Mendoza (2001). The study analyzes the effects of FX auctions on volatility of FX rates for the period February 22, 2001 to May 30, 2002. E-GARCH model is employed for the purpose of distinguishing effect of buying and selling auctions on FX rates. They also use dummy variable for signalling future exchange policy. Also, overnight interest rates are used as monetary policy tools in their models. They found that FX auctions decreases volatility. In addition, the results suggest that while selling auctions reduces the volatilities, buying ones do not have any impact on volatility. Lastly, increases in interest rates result in decreases in exchange rate volatility.

For the same purpose, Agcaer (2003) analyzed the effects and efficiency of interventions occurring between February 2001 and November 2003, including direct interventions using EGARCH models. The effects of foreign exchange auctions and interventions have been investigated not only individually but also as a whole. Findings show that the presence of CBRT in foreign exchange markets matters. Both foreign exchange auctions and interventions positively affect the level and volatilities of foreign exchange rates. Also, buying interventions affects levels of foreign exchange rates while selling interventions does not have s significant impact on them. Guimaraes & Karacadag (2004) analyzed interventions in the period from March 29, 2001, to October 3, 2003, employing Asymmetric Component Threshold GARCH (ACT-GARCH) models. According to their results, selling and buying operations do not influence level of foreign exchange rates. While sales of foreign currency reduce volatility in the short term, they lead to increases in the volatility over longer time periods.

Akinci et al. (2005a; 2005b) investigated the causes and efficiency of foreign exchange interventions in Turkey during the period between May 16, 2001, and December 31, 2003. Akinci et al. (2005a) employed probit analysis and Granger causality tests to determine the causes for the interventions in Turkey. The results suggest that volatility leads to interventions. Another finding is that, while there is a one-way causality between buying interventions and volatility, two-way causality exists between selling interventions and volatility. Akinci et al. (2005a) used the GARCH framework to analyze the effectiveness of interventions; their study found that large amounts of isolated buying interventions reduce volatility. Akinci et al. (2005b) used an event study approach with a time-varying parameter model for the same purpose; their results suggest that buying interventions in the second half of 2003 were more effective than the one in the first half of 2003.

Herrera & Ozbay (2005) employed dynamic censored regression to analyze the effect of interventions. They suggest that that there is continuity in interventions, which can be a signal for future monetary policy changes. Tunay (2008) analyzes the period between January 4, 1999, and September 24, 2008, using ARFIMA-GARCH and ARFIMA-FIGARCH models and showed that interventions increase volatility of foreign exchange rates.

Chapter 6

Data & Methodology

This chapter presents the data, methodology, and model formulation with which the study's hypotheses are analyzed.

6.1 Data Description

This study covers a period between the years 2005 and 2012 in general and between 2007 and 2010 in greater specificity. Data consists of daily values of $\frac{USD}{TRY}$, which represent selling exchange rates for those days. Total number of days is 2,015 days, excluding weekends and holidays, and direct interventions and foreign exchange auctions occurred within the period between January 4, 2005, and December 31, 2012. $\frac{USD}{TRY}$ is defined as the value of the US dollar in terms of the Turkish lira (TRY). Therefore, an increase in the exchange rate means that TRY is depreciated against USD. Therefore, while sales of USD against TRY result in the TRY appreciating in value, a purchase of USD against TRY results in the TRY being depreciated. However, the CBRT states that interventions and foreign exchange auctions conducted by it are not intended to impact the levels of exchange rates since it has no equilibrium target for these exchange rates. CBRT use direct interventions whenever there is excessive volatility because of speculation. It arranges foreign exchange buying auctions in order to maintain a strong international reserve and conducts selling auctions so as to ensure market participants liquidity in foreign currency markets. During the study period, since all interventions and auctions conducted by the CBRT were in terms of USD, we analyze effects of interventions and auctions only with respect to $\frac{USD}{TRY}$ exchange rates.

Baille & Bollerslev (1989b) describe the series of nominal exchange rates as I (1) type process. In fact, time series of nominal exchange rates under the free float regime is considered to be generated from a non-stationary process, that is, the probability distribution governing this time series does not remain the same over time. Therefore, nominal daily foreign exchange rate returns must be transformed so as to create a stationary time series. To perform this transformation, we use daily differences in the log of exchange rates, as can be seen in Equation 6.1:

$$Returns = dln(FX) = \ln(FX_t) - \ln(FX_{t-1}) \quad (6.1)$$

Figure 6.1 displays the transformed data observed between 2005 and 2012. As can be seen, extreme volatility in the foreign exchange rate $\frac{USD}{TRY}$ was observed between 2008 and 2009, when the global financial crisis started to influence the world economy.

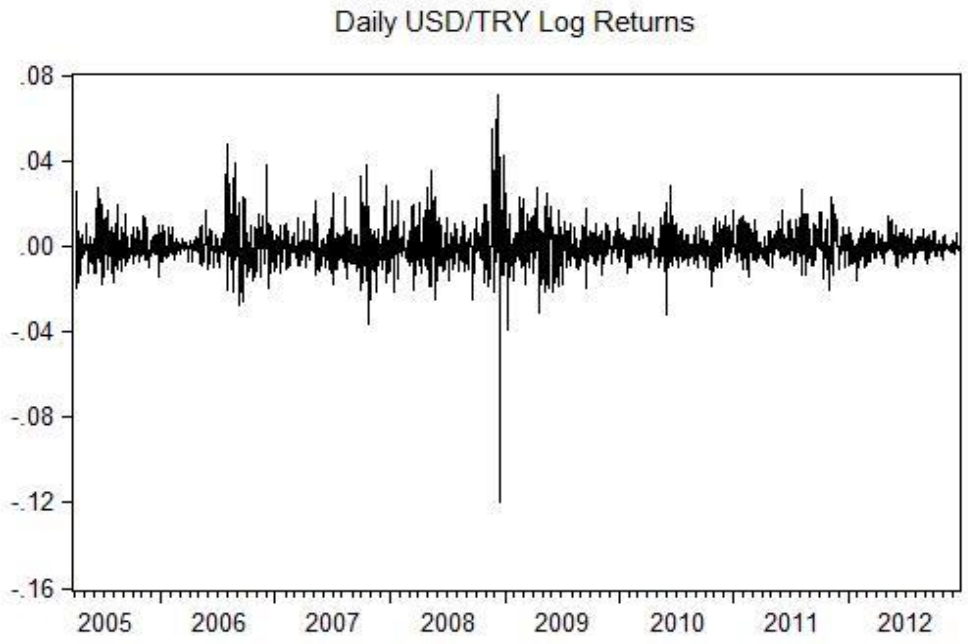


Figure 6.1: Volatility in USD/TRY Series (Daily Differences of USD/TRY in Logarithm Form)

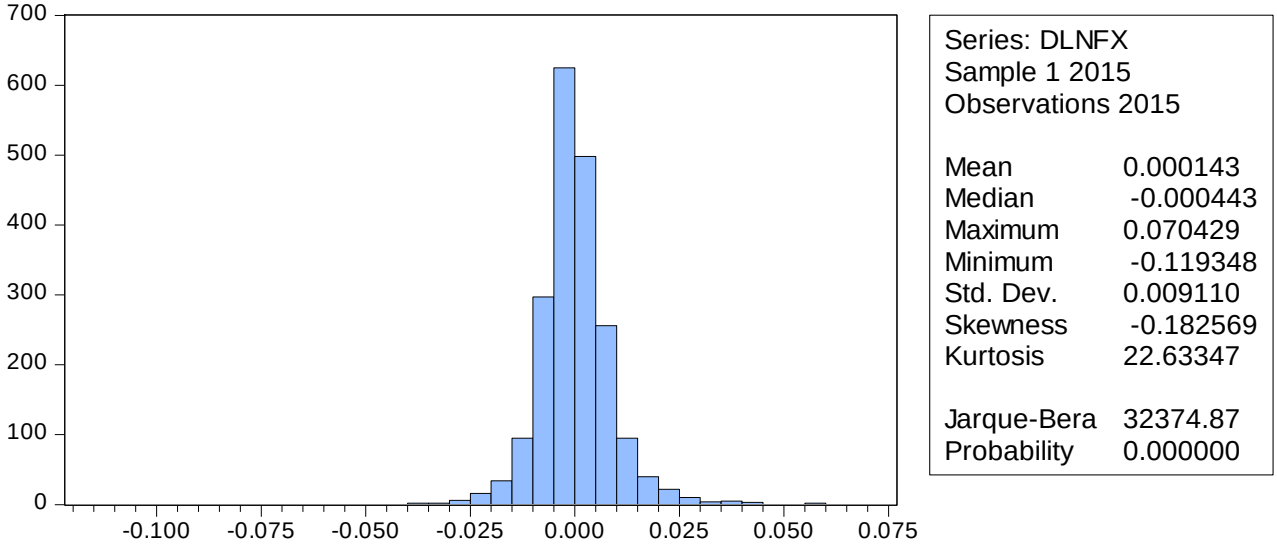


Figure 6.2: Histogram and Descriptive Statistics of USD/TRY Log Returns

Figure 6.2 is a frequency distribution of the transformed exchange rates. As can be seen, the exchange rate log returns of $\frac{USD}{TRY}$ are left skewed and are fat tailed relative to the normal distribution. Log returns also shows excess kurtosis, and the Jarque-Bera statistical test rejects the null hypothesis that these are normally distributed.

An important issue in any analysis of financial time series is that the data in the series are usually non-stationary. Therefore, before construction of a model, tests to determine whether a data series is stationary or not must be performed. Several such tests are available, and our study employed the Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. Both the ADF and PP test statistics test the null hypothesis that a series of log returns contains unit root, that is, that the characteristic function of the process contains the unit root 1. The KPSS statistical test, however, tests the null hypothesis that a series is stationary. These tests were first conducted with only a constant term and then repeated with constant and trend terms.

Table 6.1: Augmented Dickey-Fuller Test on USD/TRY Log Returns

	Akaike Info Criterion	**Schwarz Info Criterion**
With Constant	-10.72*	-44.35*
With Constant and Trend	**-10.73***	**-44.34***

Table 6.2: Phillips-Perron Test on USD/TRY Log Returns

	PP Test Statistic
With Constant	-44.347*
With Constant and Trend	**-44.340***

(*): Significant at 1 % level

Table 6.3: Kwiatkowski-Phillips-Schmidt-Shin Test (KPSS) on USD/TRY Log Returns

	KPSS Test Statistic
With Constant	0.058*
With Constant and Trend	**0.036***

(*): Significant at 1 % level.

As shown in Tables 6.1, 6.2, and 6.3, the tests indicate that the data series of the log returns of $\frac{USD}{TRY}$ foreign exchange rates is stationary.

In addition, we considered the overnight interest rate to be a primary tool in monetary policy. Under the inflation-targeting regime, the CBRT has started using short-term interest rates. In our study, since we also want to capture the effects of monetary policy on foreign

exchange rates, we try to capture the impact of any policy changes on these rates by examining changes in overnight interest rates during our study period.[7]

As can be seen from Figures 6.3 and 6.4, overnight interest rates tended to decrease over the study period. Important to note is a sharp decrease in borrowing and lending rates between 2008 and 2010 during the financial crisis, a period marked by a serious lack of liquidity in global markets.

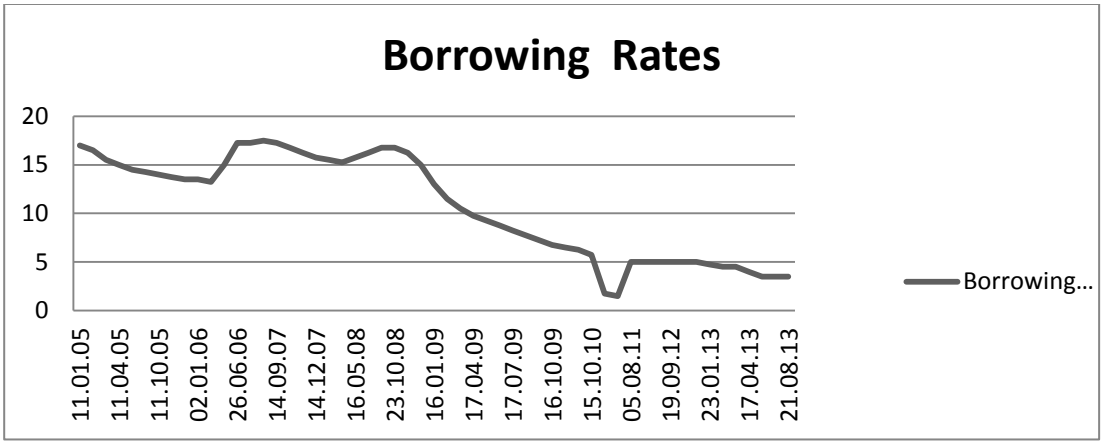


Figure 6.3: Changes in Overnight Interest rates between 2005 and 2012 (Borrowing Rates)

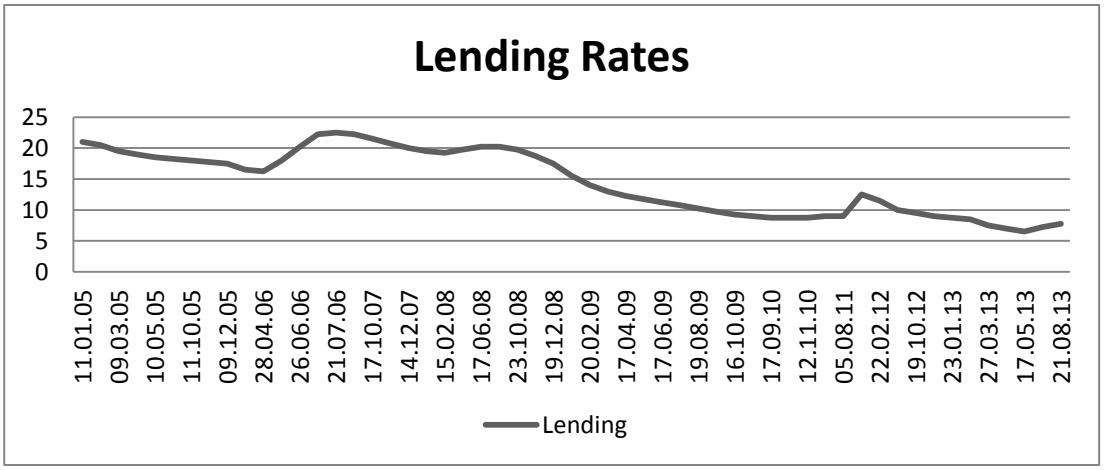


Figure 6.4: Changes in Overnight Interest rates between 2005 and 2012 (Lending Rates)

[7] We use changes in lending rates for our study.

6.2 Methodology: Theoretical Framework of E-GARCH Model

Most financial time series do not have constant means and variances. More specifically, most the financial series display relatively calm periods followed by period of high volatility or vice versa. Since the ARCH and GARCH family of models can capture low- and high-volatility periods, they are commonly used in the investigation of financial time series. One disadvantage of using the GARCH family of models is that analyses of time series using different models may yield different and complicated results. For this reasons, some researchers have turned to the event study approach in recent years (Agcaer, 2003). On the other hand, in foreign exchange rate volatility analyses, autoregressive conditional heteroscedasticity (ARCH) by Engle (1982) and generalized autoregressive conditional heteroscedasticity (GARCH) by Bollerslev (1986) have been shown to provide good fits for many exchange rate series (Ozturk, 2006). Also, the convenience and easy applicability of the GARCH family of methods is their most important advantage. In conclusion, GARCH and models derived from the standard GARCH model, such as FI-GARCH, E-GARCH, MGARCH, and etc., have been common methods used to analyze the effects of interventions on foreign exchange rates.

In this study, E-GARCH models were employed to determine whether interventions of the CBRT during our study period influenced both the level and volatility of foreign exchange rates. In contrast to the standard GARCH model, the E-GARCH model allows us to distinguish the impacts of buying and selling operations on foreign exchange rates. Because standard GARCH models do not allow inclusion of negative values describing selling interventions, determining whether selling and buying operations impact level and volatility of foreign exchange rates differently. Since the E- GARCH model allows us to define selling interventions using negative values, comparison of the impacts of buying and selling operations on exchange rates is more feasible. Because of this advantage of the E-GARCH model, most recent studies focusing on the influence of central bank foreign exchange operations in Turkey employed E-GARCH models. For instance, Domac & Mendoza (2002) used E-GARCH models to analyze the effects of foreign exchange auctions on foreign exchange rates, and the study results indicate that foreign exchange auctions do not increase volatility but that, in fact, only selling auctions reduce volatility. Agcaer (2003) used E-GARCH together with an event approach. Ozturk (2006) also employed both E-GARCH and standard GARCH models.

The standard GARCH model assumes that negative and positive shocks of the same absolute values have the same impact on future conditional variances (Ozturk, 2006). In other words, the standard GARCH model neglects the ‘‘asymmetric” or ‘‘leverage effect,’’ which

states that an unexpected drop tends to increase volatility more than does an unexpected increase having the same absolute value. On the other hand, an asymmetric effect is a property found in most financial time series, such as foreign exchange rate series. Therefore, Nelson (1991) added a term to the standard GARCH variance equation to capture the asymmetric effect. Exponential autoregressive conditional heteroscedasticity (E-GARCH) was first introduced by Nelson (1991). In contrast to the standard GARCH model, Nelson (1991) also employed the log transformed conditional variance to eliminate the restriction on the coefficient being positive. Equation 6.2 is the variance equation of the E- GARCH model:

$$\ln(\sigma_t^2) = \omega + \sum_{i=1}^{q} \alpha_i(\theta z_{t-i} + \gamma[|z_{t-i}| - E|z_{t-i}|]) + \sum_j^p \phi_j \, ln\sigma_{t-j}^2 \qquad (6.2)$$

When α_i is greater than zero, the deviation of $|z_{t-i}|$ from its expected value results in the variance of ε_t being larger than otherwise, an effect similar to the idea underlying the standard GARCH. The term z_{t-i} multiplied by θ allows the sign of the errors to influence the value of the conditional variance. Also, multiplying $|z_{t-i}|$ by γ captures a different size effect. When it comes to the leverage effect, the following are true:

- If θ = 0→ there is no leverage effect
- If θ < 0 → there is a leverage effect
- If -1 < θ < 0→ positive shocks increase volatility less than do negative shocks
  If θ < -1 → positive shocks decrease volatility while negative ones still increase it.

In summary, the E-GARCH method has two main advantages: First, since $ln\sigma_t^2$ is included in the model, σ_t^2 is always positive although the parameters are negative. Second, the E-GARCH model accounts for the leverage effect, as mentioned above.

6.3 Methodology: Models

Central banks' foreign exchange interventions aim to influence the level or volatility of foreign exchange rates or both at the same time. Usually, interventions are used to reduce volatility and change the level of exchange rates in a direction that policymakers want to see. Sometimes, although interventions on level of foreign exchange rates move rates in the direction desired, they might also increase volatility. Therefore, we distinguish the concept of 'efficiency' with respect to level and with respect to volatility. Since the CBRT states that it has no equilibrium target for foreign exchange rate level, the intervention operations and auctions conducted by the CBRT that are included in our study period should have no impact on the level of foreign exchange rates. On the other hand, the CBRT states that whenever excessive volatility occurs, it

is ready to act, in the form of direct interventions, to ease volatility. Thus, we can infer that a goal of the CBRT is to reduce volatility and, therefore, that direct interventions or auctions conducted by the CBRT should decrease volatility of foreign exchange rates.

In this study, we will first attempt to investigate effects of CBRT operations on foreign exchange markets, including interventions and foreign exchange auctions as a whole during the period between January 4, 2005, and December 31, 2012. For this purpose, this study will look at net size (i.e., magnitude) of operations carried out by the CBRT through interventions and auctions. In contrast to other studies focusing on Turkey, our study period covers a larger time period and includes the time preceding and during the global financial crisis and includes the European Debt Crisis. Additionally, from a more domestic viewpoint, our study period includes the explicit inflation-targeting regime which was launched in 2006. From these two perspectives, our study period is interesting in that it analyzes CBRT's operations during a time of financial turmoil with an explicit inflation targeting regime. In contrast to Domac & Mendoza (2001), our study will also use direct interventions together with foreign exchange auctions so as to investigate the effects of all operations of the CBRT on foreign exchange rates.

To sum up, our first hypothesis, based in part on the CBRT's official statement, is that CBRT operations from January 4, 2005, and December 31, 2012, did not affect the equilibrium level of foreign exchange rates but did reduce volatility of foreign exchange rates. The model described by Equations 6.3 and 6.4 below formulate this first hypothesis. Specifically, Equation 6.3 describes the model's mean equation, and Equation 6.4 the model's variance equation.

Model 1:

$$R_t = \beta_0 + \beta_{intv} INTV + \beta_{dintv} D^{INTV} + \beta_{dmon} D^{MON} + \beta_{up} On^{up} + \beta_{down} On^{down} + \varepsilon_t \quad (6.3)$$

$$\ln(\sigma_t^2) = \omega + \alpha(|z_{t-1}| + \gamma z_{t-1}) + \phi ln(\sigma_{t-1}^2) + \delta_{intv} INTV + \delta_{dintv} D^{INTV} + \delta_{dmon} D^{MON} + \delta_{up} On^{up} + \delta_{down} On^{down} \quad (6.4)$$

As a second area of interest, our study will attempt to investigate whether there is difference between selling and buying operations of the CBRT. Since the CBRT states that it can use direct interventions in the form of either purchases or sales when there is excessive volatility,[8] we can assume that both types of transactions might have the same impact on foreign exchange volatility, including auctions with direct interventions. Thus, these operations should reduce volatility while not influencing foreign exchange rate level. More precisely, our second hypothesis is that there is no difference in impact of buying and selling transactions on foreign exchange rates. For the analysis of this hypothesis, we use the model below which consists of mean and variance equations, shown in Equations 6.5 and 6.6, respectively.

[8] CBRT Monetary and Exchange Rate Policy for 2005, 2006, 2007, 2008, 2009, 2010, 2011, and 2012

Model 2:

$$R_t = \beta_0 + \beta_{PURCH}PURCH + \beta_{SALES}SALES + \beta_{dPURCH}D^{PURCH} + \beta_{dSALES}D^{SALES} + \beta_{dMON}D^{MON} + \beta_{up}On^{up} + \beta_{down}On^{down} + \varepsilon^t \quad (6.5)$$

$$ln(\sigma_t^2) = \omega + \alpha(|e_{t-1}| + \gamma e_{t-1}) + \phi \ln(\sigma_{t-1}^2) + \delta_{PURCH}PURCH + \delta_{SALES}SALES + \delta_{dPURCH}D^{PURCH} + \delta_{dSALES}D^{SALES} + \delta_{dMON}D^{MON} + \delta_{up}On^{up} + \delta_{down}On^{down} \quad (6.6)$$

As a new contribution to existing literature concerning CBRT interventions, this study examines the influences of foreign exchange buying auctions on level and volatility of foreign exchange rates. As mentioned earlier, in the period between 2007 and 2010, CBRT mostly conducted foreign exchange buying auctions to increase international reserves under the moderate reserve accumulation policy pursued since 2002. CBRT therefore conducted 769 daily buying auctions as a total number of buying auctions. For this analysis, we focus only on foreign exchange buying auctions in the period between January 4, 2007, and December 31, 2010, in which CBRT purchased a total of US$ 35,921 million through buying auctions. The CBRT also increased its international reserve by US$ 22.7 billion from the end of 2006 to the end of 2010, although the global financial crisis led to a suspension in buying auctions between 2008 and 2009. For this analysis, we also excluded selling auctions, which were conducted rarely relative to buying auctions in terms of total number and total size. Interestingly, the CBRT did not conduct any direct interventions despite the global financial crisis and the European Debt Crisis occurring in this same period.

The CBRT conducted two pre-announced auctions to prevent disrupting the mechanism governing the floating exchange rate regime, in which exchange rate levels are determined by market participants. Based on the CBRT's statement as to the purpose of conducting buying auctions, we can conclude, as our final hypothesis, that foreign exchange buying auctions did influence either level or volatility of foreign exchange rates while increasing international reserves. Model 3 below formulates our final hypothesis.

Model 3:

$$R_t = \beta_0 + \beta_{BAUC}BAUC + \beta_{dBAUC}D^{BAUC} + \beta_{dMON}D^{MON} + \beta_{up}On^{up} + \beta_{down}On^{down} + \varepsilon_t \quad (6.7)$$

$$ln(\sigma_t^2) = \omega + \alpha(|e_{t-1}| + \gamma e_{t-1}) + \phi \ln(\sigma_{t-1}^2) + \delta_{BAUC}BAUC + \delta_{dBAUC}D^{BAUC} + \delta_{dMON}D^{MON} + \delta_{up}On^{up} + \delta_{down}On^{down} \quad (6.8)$$

As we can see from all models, this study will attempt to investigate the impacts of monetary decisions or changes on foreign exchange rates by employing dummy variables for changes in overnight interest rates. In contrast to models presented in similar studies, we also include a dummy variable, denoted by D^{MON}, in the models to capture the Monday effect in financial series. As a general belief, we expect that returns on Mondays are smaller than ones on Friday. The variables in our models and their definitions are as follows:

- R_t is defined as daily exchange rate returns, which is the standardized log difference of $\frac{USD}{TRY}$, where $\frac{USD}{TRY}$ shows the value of TRY per one USD.

- INTV is the standardized net amount of intervention in millions of US dollars on a day, including all direct interventions and auctions conducted on that day.

- D^{INTV} is a dummy variable showing the presence of the CBRT on a particular day through interventions or auctions. Thus, it takes value of 1 when any central bank operation occurs in foreign exchange markets and when no intervention or auction occurs on a particular day.

- PURCH defines the standardized values of the total amount of purchases in US dollars on a certain day, including both buying interventions and auctions.

- D^{PURCH} is a dummy variable. It takes value of 1 when either a buying intervention or an auction is conducted on a particular day; otherwise it equals 0.

- SALES defines the standardized values of total sales amounts US dollars on a day, including both selling interventions and auctions.

- D^{SALES} is a dummy variable. It takes a value of 1 when either selling intervention or auctions are conducted on a particular day; otherwise equals 0.

- BAUC is a variable defining the standardized amount of purchases in US dollars via buying auctions on a particular day.

- D^{BAUC} is the dummy variable, taking a value of 1 when a buying auction is conducted on a certain day and a 0 otherwise.

- D^{MON} is another dummy, it stands for Mondays.

- One^{up} is a dummy variable and functions as an indicator for a change in CBRT monetary policy. It takes a value of 1 when the CBRT increases overnight interest rates, and 0 otherwise.

- One^{down} is a dummy variable functioning as an indicator for a change in monetary policy by the CBRT. It takes a value of 1 when the CBRT decreases overnight interest rates and value of 0 otherwise.

Before presenting the study's results, we would like to highlight some crucial points concerning our models and the way that the results were obtained. First, we use the standardized variables in our regression models because the amounts of interventions and auctions were large numbers in US dollar while daily exchange rates of USD/TRY which also defined in terms of TRY. Thus, we converted the variables which are daily exchange rates and amount variables, such as INTV, PURCH, SALES and BAUC, to their standardized forms so as to see the effects of the amount variables on exchange rates more coherently.[9]

Also, we estimate the models with robust standard errors to ensure accuracy of predictions of prediction of our models.[10] More clearly, we employ robust standard errors so as to obtain proper statistical inferences of estimation results.

[9] Variables x_i were standardized as follows:

$x_i = \frac{X_i - Observed\ Mean(x_i)}{Observed\ Standard\ Deviation(X_i)}$.

[10] See, for example, Engel (2001) and Bollerslev & Wooldridge (1992) for the details.

Chapter 7
Results

In this chapter we present the results regarding the models presented in the previous chapter. In establishing the results of each model, we will also comment on the significance of the estimated model parameters. A significance level of 0.05 was selected for evaluation of parameters. Estimation results for Models 1, 2, and 3 are presented in Tables 7.1, 7.2, and 7.3, respectively, which are presented on the following pages.

Table 7.1: The Results of Model 1

Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
β_0	-0.005044	0.025607	-0.196958	0.8439
β_{INTV}	-0.013357	0.012048	-1.108692	0.2676
β_{dINTV}	0.016317	0.032616	0.500286	0.6169
β_{dMON}	0.042208	0.035452	1.190581	0.2338
β_{up}	-0.275965	0.374591	-0.736708	0.4613
β_{down}	0.072220	0.095254	0.758188	0.4483
Variance Equation				
ω	-0.122359	0.045810	-2.671000	0.0076
α	0.212932	0.037745	5.641287	0.0000
ϕ	0.079925	0.021444	3.727085	0.0002
γ	0.974969	0.009625	101.2980	0.0000
δ_{INTV}	0.006476	0.014849	0.436113	0.6628
δ_{dINTV}	0.015812	0.013755	1.149576	0.2503
δ_{dMON}	-0.310706	0.143375	-2.167082	0.0302
δ_{up}	0.256723	0.233605	1.098962	0.2718
δ_{down}	-0.111468	0.153600	-0.725706	0.4680
Akaike info criterion	2.423114			
Schwarz criterion	2.464864			

Table 7.2: The Results of Model 2

Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
β_0	-0.004138	0.025344	-0.163255	0.8703
β_{PURCH}	0.001937	0.010958	0.176785	0.8597
β_{SALES}	-0.033394	0.015802	-2.113212	0.0346
β_{dPURCH}	0.006071	0.032336	0.187750	0.8511
β_{dSALES}	0.100794	0.098500	1.023283	0.3062
δ_{dMON}	0.042400	0.035851	1.182669	0.2369
δ_{up}	-0.450666	0.305532	-1.475020	0.1402
δ_{down}	0.072866	0.093405	0.780106	0.4353
Variance Equation				
ω	-0.125712	0.045871	-2.740585	0.0061
α	0.213175	0.037463	5.690244	0.0000
ϕ	0.077950	0.021638	3.602366	0.0003
γ	0.977437	0.009315	104.9269	0.0000
β_{PURCH}	0.023493	0.016240	1.446606	0.1480
β_{SALES}	-0.026653	0.009664	-2.757851	0.0058
β_{dPURCH}	0.009906	0.014554	0.680624	0.4961
β_{dSALES}	-0.020388	0.034059	-0.598615	0.5494
δ_{dMON}	-0.289044	0.143597	-2.012884	0.0441
δ_{up}	0.016030	0.245948	0.065176	0.9480
δ_{down}	-0.106822	0.153109	-0.697685	0.4854
Akaike info criterion	2.423051			
Schwarz criterion	2.475934			

Table 7.3: The Results of Model 3

Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
β_0	-0.017071	0.069467	-0.245746	0.8059
β_{BAUC}	0.050032	0.037405	1.337570	0.1810
β_{dBAUC}	-0.070515	0.100865	-0.699107	0.4845
δ_{dMON}	0.075436	0.062211	1.212585	0.2253
β_{up}	-0.451011	0.292170	-1.543660	0.1227
β_{down}	-0.043365	0.228772	-0.189558	0.8497
Variance Equation				
ω	-0.087020	0.054828	-1.587136	0.1125
α	0.184620	0.059988	3.077588	0.0021
ϕ	0.108040	0.030071	3.592786	0.0003
γ	0.957727	0.026875	35.63672	0.0000
δ_{BAUC}	0.001693	0.009838	0.172064	0.8634
δ_{dBAUC}	-0.010484	0.031432	-0.333534	0.7387
δ_{dMON}	-0.246636	0.202363	-1.218782	0.2229
δ_{up}	-0.199164	0.465135	-0.428185	0.6685
δ_{down}	-0.018728	0.226015	-0.082861	0.9340

Akaike info criterion	2.771511
Schwarz criterion	2.844836

Beginning with the results of first model, we did not find any statistically significant impact of net amount of interventions and FX auctions as a whole on the level or on the volatility of FX rates. In addition, we did not find that the presence of CBRT in FX markets influences level or volatility of FX rates. The only significant coefficient belongs to the dummy variable used to capture Monday effect on the volatility of FX rates, while it is statistically insignificant in the mean equation.

The results concerning the second model are interesting. In the mean regression, the amount of foreign currency purchases through direct interventions or foreign exchange buying auctions did not have any statistically significant impact on level of USD/TRY exchange rates. Similarly, this amount did not influence volatility of USD/TRY foreign exchange rates. Also, coefficients of dummy variable used to capture the impact of the presence of buying operations on level and volatility did not show any statistical significance.

On the other hand, amount of sales by direct interventions or selling auctions was found to have a statistically significant impact on both level and volatility of USD/TRY foreign exchange rates. However, the coefficients of the dummy variables employed to capture the effects of selling operations in the foreign exchange rates market were not found to be statistically significant in the mean or in the variance equations. The *Monday* effect on federal exchange rates is statistically significant with respect to volatility of exchange rates as shown by the Model 1 results.

In Model 3's results, we do not see any statistically significant effect of both size and presence of foreign exchange buying auctions on level or volatility. In contrast to the results found with respect to the first two models, the *Monday effect* did not statistically affect the volatility of USD/TRY foreign exchange rates.

According to the results of these three models, increase or decrease in overnight interest rates did not have any statistically significant impact on exchange rates. On the other hand, the GARCH and E-GARCH terms in the variance equations of all models are highly statistically significant.

Chapter 8
Discussion

In this chapter, the results and significance or insignificance of the estimated coefficients are evaluated. Since this study investigates the impacts of the CBRT operation through direct interventions and auctions to show whether CBRT operations are effective or not along with CBRT's official statements.

As CBRT states that

- It conducts direct interventions to reduce excessive volatility without influencing equilibrium level of FX rates,
- It conducts FX buying auctions only to increase international reserves. Also it states that to not affect process of the floating exchange rate regime, auctions are pre-announced in terms of time and amount.

According to CBRT official statements and purposes about conducting direct interventions and FX auctions above, our findings show the following:

First of all, in our first model, effects of CBRT operations including both intervention and auction are investigated .The results show that, there is no any impact of CBRT operations on FX rates in terms of both amount of operations and presence of CBRT in FX market.

In our second model, our study analyzes any difference in selling and buying operations with respect to their impact on FX rates. We found that there is asymmetric effect between amount of selling and buying operation of CBRT on FX rates. While amounts of buying interventions and buying auctions as a whole did not influences exchange rate's level or volatility, amount of selling interventions with selling auctions result in decreases in USD/TRY parity and volatility. That is, selling operations as whole increases the value of TRY against the USD. Also amount of selling operations reduces the volatility.

According to the results of model 3, FX buying auction does not influences level or volatility of FX rates. Along with CBRT statement about FX buying auctions, we can conclude that FX buying auction was an effective intervention policy during the period between 2007 and 2010.

Furthermore, the findings show that Monday effect is observed when considering its impact on volatility. During whole study period between 2005 and 2012, volatility tends to decrease on Mondays. In addition, our study tried to capture the effect of monetary policy changes on exchange rates through changes in overnight interest rates. The findings did not show that any monetary policy changes influences the exchange rates.

As a comparison with findings of similar studies on Turkey, our findings mainly depart from the findings of previous studies, although some minor similarities exist. For example, while Agcaer (2003) found that net amount of operations including intervention and auctions as a whole has a significant effect on exchange rate level and volatilities, our study did not show this. Similarly, Agcaer (2003) found that the presence of CBRT in FX market affects negatively the level and volatility of exchange rates. But, our results did not show any impact of the presence of CBRT on FX rates. Another difference from Agcaer (2003) is that our study shows that the amount of sales has a significant effect on the level and volatility by reducing both of them. But, in Agcaer (2003) the amount of selling has only a positive effect on the volatility. Differently, this study found that the presence of buying operation has a negative impact on the level of FX rates. As a similar point, Agcaer (2003) did not find any significant impact of amount of buying operations either on level or volatility.

In contrast to our findings, also Domac & Mendoza (2001) found that both size and frequency of central bank operations have positive impacts on the level of exchange rates and negative impacts on volatility. Also, this study suggests that both of size and frequency of selling operations have negative impacts on volatility but, our study shows that only amount or size of the sales has negative impact on it. Domac & Mendoza (2001) similarly found that amount of sales results in increase in value of TRY against USD and purchases of USD do not have any effect on exchange rates.

As a conclusion, our study brings new and different results in some points. Also, when considering the efficiency of the CBRT interventions and auctions during the period between 2005 and 2012 as a whole, amounts of sales were effective with respect to volatility issues. Also FX buying auctions were served well for the purpose of increasing international reserves.

Chapter 9
Conclusion

After the breakdown of the Bretton Woods System, developed countries continued to intervene in exchange markets until the middle of the 1990s. But in today's world, foreign exchange interventions are used commonly and frequently in emerging market economies. The efficiency of interventions has high importance in the developing countries where the stability of exchange rates is still important. Because the stability of exchange rate influences the macroeconomy of the country through the various channels such as inflation, export, growth and even unemployment rate. In addition, the impact of the exchange rate fluctuation on the real economy, stability of exchange rate is also important in a country which lacks of accountability because the country can suffer a lot from the high risk premiums. Therefore, our study investigates the efficiency of interventions in Turkey between 4.1.2005 and 31.12.2012.

Also our study period covers crucial crises times such as the global financial crisis and the European Sovereign Debt Crisis. In this respect, it is interesting to analyze the effects of the interventions on exchange rates in Turkey on this period as a whole and on a sub-period which covers the period between 4.1.2007 and 31.12.2010.

The findings of this study are that only the amount of sales of US dollars has an impact on the exchange rates. Since it causes to decreases in USD/TRY parity while it leads to the appreciation of TRY. In addition to decreases in level of exchange rates, amount of selling transactions reduces the volatility. Also, FX buying auctions in the period between 4.1.2007 and 31.12.2010 did not influence either level or volatility. In this respect, they were an efficient tool to increase international reserves since CBRT conducts FX buying auctions for the moderate reserve accumulation policy.

In conclusion, size of selling transactions of CBRT decreased the volatility. CBRT states that it takes the action when excessive volatility is observed and it tries to reduce excessive volatility. Therefore, CBRT can use selling interventions by increases in amounts of sales for volatility issue but CBRT must also notice that the amount of selling transaction leads to the appreciation of TRY. Furthermore, CBRT use pre-announced FX buying auctions in order to not disrupt the mechanism of floating exchange rate regime. These buying auctions conducted to increase international reserves. In our sub-period, buying auctions can be considered as an

effective policy for the purpose of the reserve accumulation without any impact on level or volatility of exchange rates.

The efficiency of interventions will remain open for further research especially for researches focused on emerging market economies or developing countries. Because there is a limited number of studies have been made on interventions in developing countries. Also, since there are different results for different countries or even for the same country in different periods, researchers are motivated to study on the efficiency of the central bank foreign exchange interventions and find new and different results in this field.

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Appendix A: The Regression Outputs

Appendix A1: The Results of Model 1

Dependent Variable: R
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 12/15/13 Time: 16:40
Sample: 1 2015
Included observations: 2015
Convergence achieved after 56 iterations
Bollerslev-Wooldridge robust standard errors & covariance
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(7) + C(8)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(9)
*RESID(-1)/@SQRT(GARCH(-1)) + C(10)*LOG(GARCH(-1)) + C(11)
*INTV + C(12)*DINTV + C(13)*MON + C(14)*ONUP + C(15)*ONDOWN

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.005044	0.025607	-0.196958	0.8439
INTV	-0.013357	0.012048	-1.108692	0.2676
DINTV	0.016317	0.032616	0.500286	0.6169
MON	0.042208	0.035452	1.190581	0.2338
ONUP	-0.275965	0.374591	-0.736708	0.4613
ONDOWN	0.072220	0.095254	0.758188	0.4483
Variance Equation				
C(7)	-0.122359	0.045810	-2.671000	0.0076
C(8)	0.212932	0.037745	5.641287	0.0000
C(9)	0.079925	0.021444	3.727085	0.0002
C(10)	0.974969	0.009625	101.2980	0.0000
C(11)	0.006476	0.014849	0.436113	0.6628
C(12)	**0.015812**	**0.013755**	**1.149576**	**0.2503**
C(13)	**-0.310706**	**0.143375**	**-2.167082**	**0.0302**
C(14)	0.256723	0.233605	1.098962	0.2718
C(15)	-0.111468	0.153600	-0.725706	0.4680

R-squared	0.001364	Mean dependent var	0.015700
Adjusted R-squared	-0.001121	S.D. dependent var	1.000000
S.E. of regression	1.000561	Akaike info criterion	2.423114
Sum squared resid	2011.253	Schwarz criterion	2.464864
Log likelihood	-2426.287	Hannan-Quinn criter.	2.438438
Durbin-Watson stat	1.980873		

Appendix A2: The Results of Model 2

Dependent Variable: R
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 12/15/13 Time: 16:57
Sample: 1 2015
Included observations: 2015
Convergence achieved after 78 iterations
Bollerslev-Wooldridge robust standard errors & covariance
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(9) + C(10)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(11)
*RESID(-1)/@SQRT(GARCH(-1)) + C(12)*LOG(GARCH(-1)) + C(13)
*PURCH + C(14)*DPURCH + C(15)*SALES + C(16)*DSALES + C(17)
*MON + C(18)*ONUP + C(19)*ONDOWN

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.004138	0.025344	-0.163255	0.8703
PURCH	0.001937	0.010958	0.176785	0.8597
DPURCH	0.006071	0.032336	0.187750	0.8511
SALES	**-0.033394**	**0.015802**	**-2.113212**	**0.0346**
DSALES	0.100794	0.098500	1.023283	0.3062
MON	0.042400	0.035851	1.182669	0.2369
ONUP	-0.450666	0.305532	-1.475020	0.1402
ONDOWN	0.072866	0.093405	0.780106	0.4353
Variance Equation				
C(9)	-0.125712	0.045871	-2.740585	0.0061
C(10)	0.213175	0.037463	5.690244	0.0000
C(11)	0.077950	0.021638	3.602366	0.0003
C(12)	0.977437	0.009315	104.9269	0.0000
C(13)	0.023493	0.016240	1.446606	0.1480
C(14)	0.009906	0.014554	0.680624	0.4961
C(15)	**-0.026653**	**0.009664**	**-2.757851**	**0.0058**
C(16)	-0.020388	0.034059	-0.598615	0.5494
C(17)	-0.289044	0.143597	-2.012884	0.0441
C(18)	0.016030	0.245948	0.065176	0.9480
C(19)	-0.106822	0.153109	-0.697685	0.4854

R-squared	0.002555	Mean dependent var	0.015700
Adjusted R-squared	-0.000924	S.D. dependent var	1.000000
S.E. of regression	1.000462	Akaike info criterion	2.423051
Sum squared resid	2008.854	Schwarz criterion	2.475934
Log likelihood	-2422.224	Hannan-Quinn criter.	2.442461
Durbin-Watson stat	1.983439		

Appendix A3: The Results of Model 3

Dependent Variable: RETURNS
Method: ML - ARCH (Marquardt) - Normal distribution

Date: 12/15/13 Time: 17:10
Sample: 1 1005
Included observations: 1005
Convergence achieved after 98 iterations
Bollerslev-Wooldridge robust standard errors & covariance
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(7) + C(8)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(9)
*RESID(-1)/@SQRT(GARCH(-1)) + C(10)*LOG(GARCH(-1)) + C(11)
*BAUC + C(12)*DBAUC + C(13)*MONDAY + C(14)*ONUP + C(15)
*ONDOWN

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.017071	0.069467	-0.245746	0.8059
BAUC	**0.050032**	**0.037405**	**1.337570**	**0.1810**
DBAUC	-0.070515	0.100865	-0.699107	0.4845
MONDAY	0.075436	0.062211	1.212585	0.2253
ONUP	-0.451011	0.292170	-1.543660	0.1227
ONDOWN	-0.043365	0.228772	-0.189558	0.8497
Variance Equation				
C(7)	-0.087020	0.054828	-1.587136	0.1125
C(8)	0.184620	0.059988	3.077588	0.0021
C(9)	0.108040	0.030071	3.592786	0.0003
C(10)	0.957727	0.026875	35.63672	0.0000
C(11)	0.001693	0.009838	0.172064	0.8634
C(12)	-0.010484	0.031432	-0.333534	0.7387
C(13)	-0.246636	0.202363	-1.218782	0.2229
C(14)	-0.199164	0.465135	-0.428185	0.6685
C(15)	-0.018728	0.226015	-0.082861	0.9340

R-squared	0.001626	Mean dependent var	0.009822
Adjusted R-squared	-0.003371	S.D. dependent var	1.168674
S.E. of regression	1.170643	Akaike info criterion	2.771511
Sum squared resid	1369.034	Schwarz criterion	2.844836
Log likelihood	-1377.684	Hannan-Quinn criter.	2.799373
Durbin-Watson stat	1.969293		

Appendix A4: Unit Root Tests

Appendix A4.1: ADF Test Results with Constant

Null Hypothesis: DLNFX has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-44.35072	0.0001
Test critical values:	1% level	-3.433398	
	5% level	-2.862773	
	10% level	-2.567473	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLNFX)
Method: Least Squares
Date: 01/05/14 Time: 17:08
Sample (adjusted): 2 2015
Included observations: 2014 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNFX(-1)	-0.988681	0.022292	-44.35072	0.0000
C	0.000141	0.000203	0.692755	0.4885

R-squared	0.494344	Mean dependent var	-8.59E-07
Adjusted R-squared	0.494092	S.D. dependent var	0.012813
S.E. of regression	0.009114	Akaike info criterion	-6.557055
Sum squared resid	0.167121	Schwarz criterion	-6.551486
Log likelihood	6604.954	Hannan-Quinn criter.	-6.555011
F-statistic	1966.987	Durbin-Watson stat	2.000259
Prob(F-statistic)	0.000000		

Appendix A4.2: ADF Test Results with Trend and Constant

Null Hypothesis: DLNFX has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-44.34324	0.0000
Test critical values:	1% level	-3.962605	
	5% level	-3.412041	
	10% level	-3.127931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLNFX)
Method: Least Squares
Date: 01/05/14 Time: 17:12
Sample (adjusted): 2 2015
Included observations: 2014 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNFX(-1)	-0.988760	0.022298	-44.34324	0.0000
C	4.23E-07	0.000406	0.001040	0.9992
@TREND(1)	1.39E-07	3.49E-07	0.398545	0.6903

R-squared	0.494384	Mean dependent var	-8.59E-07
Adjusted R-squared	0.493881	S.D. dependent var	0.012813
S.E. of regression	0.009116	Akaike info criterion	-6.556141
Sum squared resid	0.167107	Schwarz criterion	-6.547788
Log likelihood	6605.034	Hannan-Quinn criter.	-6.553075
F-statistic	983.1615	Durbin-Watson stat	2.000257
Prob(F-statistic)	0.000000		

Appendix A4.3: ADF Test Results with Constant

Null Hypothesis: DLNFX has a unit root
Exogenous: Constant
Lag Length: 14 (Automatic - based on AIC, maxlag=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.72753	0.0000
Test critical values:	1% level	-3.433420	
	5% level	-2.862783	
	10% level	-2.567478	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLNFX)
Method: Least Squares
Date: 01/05/14 Time: 17:13
Sample (adjusted): 16 2015
Included observations: 2000 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNFX(-1)	-0.922374	0.085982	-10.72753	0.0000
D(DLNFX(-1))	-0.066103	0.083727	-0.789517	0.4299
D(DLNFX(-2))	-0.052085	0.080742	-0.645085	0.5189
D(DLNFX(-3))	-0.032856	0.077411	-0.424427	0.6713
D(DLNFX(-4))	-0.016708	0.073898	-0.226103	0.8211
D(DLNFX(-5))	-0.064040	0.070133	-0.913125	0.3613
D(DLNFX(-6))	-0.095050	0.066042	-1.439233	0.1502
D(DLNFX(-7))	-0.085930	0.061977	-1.386493	0.1658
D(DLNFX(-8))	-0.097435	0.057734	-1.687660	0.0916
D(DLNFX(-9))	-0.132104	0.053087	-2.488458	0.0129
D(DLNFX(-10))	-0.116723	0.048372	-2.413016	0.0159
D(DLNFX(-11))	-0.105969	0.043623	-2.429199	0.0152
D(DLNFX(-12))	-0.101153	0.038092	-2.655514	0.0080
D(DLNFX(-13))	-0.066643	0.031351	-2.125709	0.0337
D(DLNFX(-14))	0.046988	0.022303	2.106825	0.0353
C	0.000136	0.000202	0.673736	0.5006

R-squared	0.506308	Mean dependent var	2.57E-06
Adjusted R-squared	0.502575	S.D. dependent var	0.012782
S.E. of regression	0.009015	Akaike info criterion	-6.571886
Sum squared resid	0.161240	Schwarz criterion	-6.527078
Log likelihood	6587.886	Hannan-Quinn criter.	-6.555433
F-statistic	135.6464	Durbin-Watson stat	2.001643
Prob(F-statistic)	0.000000		

Appendix A4.4: ADF Test Results with Trend and Constant

Null Hypothesis: DLNFX has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 14 (Automatic - based on AIC, maxlag=25)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.73013	0.0000
Test critical values:	1% level	-3.962637	
	5% level	-3.412056	
	10% level	-3.127940	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DLNFX)
Method: Least Squares
Date: 01/05/14 Time: 17:14
Sample (adjusted): 16 2015
Included observations: 2000 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNFX(-1)	-0.923529	0.086069	-10.73013	0.0000
D(DLNFX(-1))	-0.065008	0.083808	-0.775674	0.4380
D(DLNFX(-2))	-0.051059	0.080817	-0.631782	0.5276
D(DLNFX(-3))	-0.031901	0.077480	-0.411729	0.6806
D(DLNFX(-4))	-0.015822	0.073960	-0.213927	0.8306
D(DLNFX(-5))	-0.063230	0.070189	-0.900853	0.3678
D(DLNFX(-6))	-0.094317	0.066092	-1.427050	0.1537
D(DLNFX(-7))	-0.085283	0.062020	-1.375092	0.1693
D(DLNFX(-8))	-0.096873	0.057771	-1.676858	0.0937
D(DLNFX(-9))	-0.131633	0.053117	-2.478181	0.0133
D(DLNFX(-10))	-0.116338	0.048396	-2.403860	0.0163
D(DLNFX(-11))	-0.105680	0.043641	-2.421559	0.0155
D(DLNFX(-12))	-0.100949	0.038105	-2.649221	0.0081
D(DLNFX(-13))	-0.066509	0.031360	-2.120806	0.0341
D(DLNFX(-14))	0.047051	0.022309	2.109111	0.0351
C	1.61E-05	0.000408	0.039592	0.9684
@TREND(1)	1.18E-07	3.50E-07	0.338596	0.7349

R-squared	0.506336	Mean dependent var	2.57E-06
Adjusted R-squared	0.502353	S.D. dependent var	0.012782
S.E. of regression	0.009017	Akaike info criterion	-6.570943
Sum squared resid	0.161231	Schwarz criterion	-6.523336
Log likelihood	6587.943	Hannan-Quinn criter.	-6.553463
F-statistic	127.1190	Durbin-Watson stat	2.001643
Prob(F-statistic)	0.000000		

Appendix A4.5: PP Test Results with Constant

Null Hypothesis: DLNFX has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-44.34763	0.0001
Test critical values:	1% level	-3.433398	
	5% level	-2.862773	
	10% level	-2.567473	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	8.30E-05
HAC corrected variance (Bartlett kernel)	8.10E-05

Phillips-Perron Test Equation
Dependent Variable: D(DLNFX)
Method: Least Squares
Date: 01/05/14 Time: 17:15
Sample (adjusted): 2 2015
Included observations: 2014 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNFX(-1)	-0.988681	0.022292	-44.35072	0.0000
C	0.000141	0.000203	0.692755	0.4885

R-squared	0.494344	Mean dependent var	-8.59E-07
Adjusted R-squared	0.494092	S.D. dependent var	0.012813
S.E. of regression	0.009114	Akaike info criterion	-6.557055
Sum squared resid	0.167121	Schwarz criterion	-6.551486
Log likelihood	6604.954	Hannan-Quinn criter.	-6.555011
F-statistic	1966.987	Durbin-Watson stat	2.000259
Prob(F-statistic)	0.000000		

Appendix A4.6: PP Test Results with Trend and Constant

Null Hypothesis: DLNFX has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-44.34007	0.0000
Test critical values:	1% level	-3.962605	
	5% level	-3.412041	
	10% level	-3.127931	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	8.30E-05
HAC corrected variance (Bartlett kernel)	8.09E-05

Phillips-Perron Test Equation
Dependent Variable: D(DLNFX)
Method: Least Squares
Date: 01/05/14 Time: 17:16
Sample (adjusted): 2 2015
Included observations: 2014 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNFX(-1)	-0.988760	0.022298	-44.34324	0.0000
C	4.23E-07	0.000406	0.001040	0.9992
@TREND(1)	1.39E-07	3.49E-07	0.398545	0.6903

R-squared	0.494384	Mean dependent var	-8.59E-07
Adjusted R-squared	0.493881	S.D. dependent var	0.012813
S.E. of regression	0.009116	Akaike info criterion	-6.556141
Sum squared resid	0.167107	Schwarz criterion	-6.547788
Log likelihood	6605.034	Hannan-Quinn criter.	-6.553075
F-statistic	983.1615	Durbin-Watson stat	2.000257
Prob(F-statistic)	0.000000		

Appendix A4.7: KPSS Test Results with Constant

Null Hypothesis: DLNFX is stationary
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.058119
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	8.29E-05
HAC corrected variance (Bartlett kernel)	8.26E-05

KPSS Test Equation
Dependent Variable: DLNFX
Method: Least Squares
Date: 01/05/14 Time: 17:17
Sample: 1 2015
Included observations: 2015

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000143	0.000203	0.704767	0.4810

R-squared	0.000000	Mean dependent var	0.000143
Adjusted R-squared	0.000000	S.D. dependent var	0.009110
S.E. of regression	0.009110	Akaike info criterion	-6.558405
Sum squared resid	0.167144	Schwarz criterion	-6.555621
Log likelihood	6608.593	Hannan-Quinn criter.	-6.557383
Durbin-Watson stat	1.977350		

Appendix A4.8: KPSS Test Results with Trend and Constant

Null Hypothesis: DLNFX is stationary
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

Null Hypothesis: DLNFX is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.036946
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	8.29E-05
HAC corrected variance (Bartlett kernel)	8.26E-05

KPSS Test Equation
Dependent Variable: DLNFX
Method: Least Squares
Date: 01/05/14 Time: 17:18
Sample: 1 2015
Included observations: 2015

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.56E-06	0.000406	0.008761	0.9930
@TREND(1)	1.39E-07	3.49E-07	0.396897	0.6915

R-squared	0.000078	Mean dependent var	0.000143
Adjusted R-squared	-0.000418	S.D. dependent var	0.009110
S.E. of regression	0.009112	Akaike info criterion	-6.557490
Sum squared resid	0.167131	Schwarz criterion	-6.551924
Log likelihood	6608.672	Hannan-Quinn criter.	-6.555447
F-statistic	0.157527	Durbin-Watson stat	1.977505
Prob(F-statistic)	0.691485		

Appendix B: Tables

Appendix B1: Overnight Interest Rates between 2005 and 2012

Date	Lending	Borrowing
11.01.05	21	17
09.02.05	20.5	16.5
09.03.05	19.5	15.5
11.04.05	19	15
10.05.05	18.5	14.5
09.06.05	18.25	14.25
11.10.05	18	14
09.11.05	17.75	13.75
09.12.05	17.5	13.5
02.01.06	16.5	13.5
28.04.06	16.25	13.25
08.06.06	18	15
26.06.06	20.25	17.25
28.06.06	22.25	17.25
21.07.06	22.5	17.5
14.09.07	22.25	17.25
17.10.07	21.5	16.75
15.11.07	20.75	16.25
14.12.07	20	15.75
18.01.08	19.5	15.5
15.02.08	19.25	15.25
16.05.08	19.75	15.75
17.06.08	20.25	16.25
18.07.08	20.25	16.75
23.10.08	19.75	16.75
20.11.08	18.75	16.25
19.12.08	17.5	15
16.01.09	15.5	13
20.02.09	14	11.5
20.03.09	13	10.5
17.04.09	12.25	9.75
15.05.09	11.75	9.25
17.06.09	11.25	8.75
17.07.09	10.75	8.25

19.08.09	10.25	7.75
18.09.09	9.75	7.25
16.10.09	9.25	6.75
20.11.09	9	6.5
17.09.10	8.75	6.25
15.10.10	8.75	5.75
12.11.10	8.75	1.75
17.12.10	9	1.5
05.08.11	9	5
21.10.11	12.5	5
22.02.12	11.5	5
19.09.12	10	5
19.10.12	9.5	5
21.11.12	9	5
23.01.13	8.75	4.75
20.02.13	8.5	4.5
27.03.13	7.5	4.5
17.04.13	7	4
17.05.13	6.5	3.5
24.07.13	7.25	3.5
21.08.13	7.75	3.5